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DOGS ARE EXPENSIVE:
COST-BENEFIT PERSPECTIVES ON CANID OWNERSHIP AT HOUSEPIT 54,
BRIDGE RIVER, BRITISH COLUMBIA

By
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B.A., Denison University, Granville, OH, 2014

Thesis
presented in partial fulfillment of the requirements
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ABSTRACT

Chiewphasa, Ben, M.A., Spring 2016

Anthropology

Dogs are Expensive: Cost-Benefit Perspectives on Canid Ownership at Housepit 54, Bridge River, British Columbia

Chairperson: Anna M. Prentiss

The presence of dogs in the Housepit 54 (HP 54) faunal assemblage of the Bridge River site (EeRl4) raises questions regarding their roles within Canadian Plateau prehistory, specifically their contributions to networked household economies. Ethnohistoric sources often cite dogs as “jacks of all trades,” household entities that can act as beasts of burden, hunters, prized companions, or as a husbanded food resource. The 2012-2014 field seasons yielded variation in dog frequencies throughout 10 superimposed floors (IIj-IIa); these fluctuations occurred alongside changing densities of ungulates and salmon remains. The thesis incorporates multivariate analyses to determine how dogs could have allowed HP 54 to access and acquire fauna for household use, assuming that the cost of dog upkeep did not outweigh benefits. Principal components analysis (PCA) results show strong statistical correlations between dog remains and faunal NISP (number of identified specimens) throughout the HP 54 lifespan. Under the framework of central place foraging theory, relative abundance indices were calculated to assess ungulate axial and appendicular element ratios; the goal was two-fold: 1) to indicate the periods which saw HP 54 inhabitants needing to travel greater distances in order to achieve comfortable levels of caloric intake; 2) determine if dogs were more prominent during times of resource stress. Overall, the project found that canids impacted the HP 54 economy predominately during the later stages of HP 54 lifespan up to abandonment. Dogs’ increased worth could have occurred under situational conditions. For example, an increase in greater village-wide inequality and/or an increase in the availability of salmon for feed.

ACKNOWLEDGEMENTS

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CHAPTER 1 INTRODUCTION

Dogs (*Canis familiaris*) are expensive. Domesticated dogs require significant time, energy, and resources for adequate upkeep. Despite these costs, dog husbandry became a world-wide phenomenon in almost all types of societies (Schwartz 1997:2). Domesticates have been interpreted as “living tools,” the result of human adaptation (Shipman 2010:524-525). As hunting aides, dogs have been referred to as a type of human technology similarly to the function of lithic and stone tools (Kaplan and Kopishchke 1992, Townsend 2000, Webster 1986). However, dogs’ role in different communities, cultures, and contexts extend beyond such generalizations. They appear within archaeological assemblages of complex hunter-gatherers in the Canadian Plateau, raising questions regarding what their roles were within societies characterized by emergent wealth and status based inequality. Unlike other forms of material wealth, dogs are unique in that they consume food to sustain their economic worth. In other words, their upkeep costs are greater than the manufacturing of ornaments, which would only require the availability of raw material, time, and energy; dogs require much more than this. This project seeks to determine whether there are benefits and an underlying logic to dog maintenance and ownership within a household context. Specifically, the focus will be on Housepit 54 (HP 54) of the Bridge River archaeological site, a complex fisher-forager village in British Columbia with occupation dates of ca. 1800-100 cal. BP.

Bridge River’s complex history involving emergent social complexity and inequality provides a unique opportunity to study domesticates as markers of wealth. The overarching goal of the Bridge River project aims to test hypotheses that examine the development and evolution of dense aggregate villages and socioeconomic inequality (Hayden 1997, Prentiss e al. 2003,

2005, 2007, and 2008). Investigating the potential usages of dogs in social practice can continue the conversation regarding household dynamics in Canadian Plateau prehistory. With canid remains already excavated from multiple Bridge River pithouses, the project seeks to explore HP 54 findings and ask, via multivariate statistical analyses, to what extent does keeping large packs of dogs allow for households to acquire material wealth, subsistence-based wealth, and prestige. The ultimate goal is to better understand the relationships between the generational variation in dog populations and available resources. The study will validate the importance of ethnography as the foundation for insightful research questions pertinent to First Nations archeology.

By applying anthropological frameworks in studying canid husbandry, it is possible to not only question the many ways dogs were used and deployed, but how they impacted the lives of people that owned, maintained, and oversaw their companions. Dogs must have served a vital function in society as evidenced by their consistent appearance in the archaeological record. Contrarily, upkeep costs would greatly outweigh benefits if they served no succinct purpose (Wang and Tedford 2008:156).

This thesis is divided into 6 chapters. Chapter 2 discusses the overarching cultural and environmental synopsis of the Middle Fraser Canyon. The section will explain how the Bridge River village site (EeR14) fits in within these contexts while also examining the role of dogs within different frameworks ranging from broad regional generalities down to the household level. Chapter 3 emphasizes the theoretical frameworks that ground the hypotheses and research questions; specifically, it examines how hunter-gatherer usages of dogs can be considered within a human behavioral ecological framework.

Chapter 4 outlines methods, hypotheses, and test expectations. This section provides information regarding the faunal assemblage, archaeological contexts, and the statistical

procedures. Chapter 5 illuminates the analysis and results, suggesting that dogs had major impacts in household economy, specifically during late stage HP 54 occupation. Chapter 6 will discuss these results, elaborating how dogs are fluid actors within shifting household economies where their assigned roles and village-wide worth change through time.

CHAPTER 2 BACKGROUND

This chapter begins with the cultural and environmental background for the Mid-Fraser region of the Interior Plateau. The next section later discusses the Bridge River site in greater detail and describes available food resources within the region and its importance in village-wide subsistence patterns. Lastly, the chapter gives an introduction to domestic dogs of the Interior Plateau and Pacific Northwest, discussing how these “beasts of burden” thrived within complex cultural and environmental dynamics.

Environmental Background

Bridge River: named after the watercourse that runs through the Middle Fraser Canyon and empties into the Fraser River. The convergence contributes to the rushing flow of water as it manifests into the infamous St'át'imc fishing spot; it is here where the spring or chinook salmon swims in the early warm seasons, the sockeye thrive in the late summer, and the coho emerges as the fall season swiftly approaches (Prentiss and Kuijt 2012). The St'át'imc Nation encompasses a number of bands, all of which retain their own councilors, chiefs, lands, and long-standing traditions. Lineal ties of the Bridge River occupation can be linked to today's Xwisten group (part of the Upper Lillooet).

Many Xwisten people live near the present day dwelling of Lillooet along the Fraser River. The river is one of many that continue to erode the surrounding Coast Range rocks composed of varied metamorphic, extrusive igneous and sedimentary formations. U-shaped river valleys surround the Fraser, formed by Pleistocene post-glacial erosion, leaving behind glacial

till. As glacial till gets carried by riverine systems and deposit along river banks, valley benches form. The Bridge River site sits atop one of these terraces (Chatters 1988).

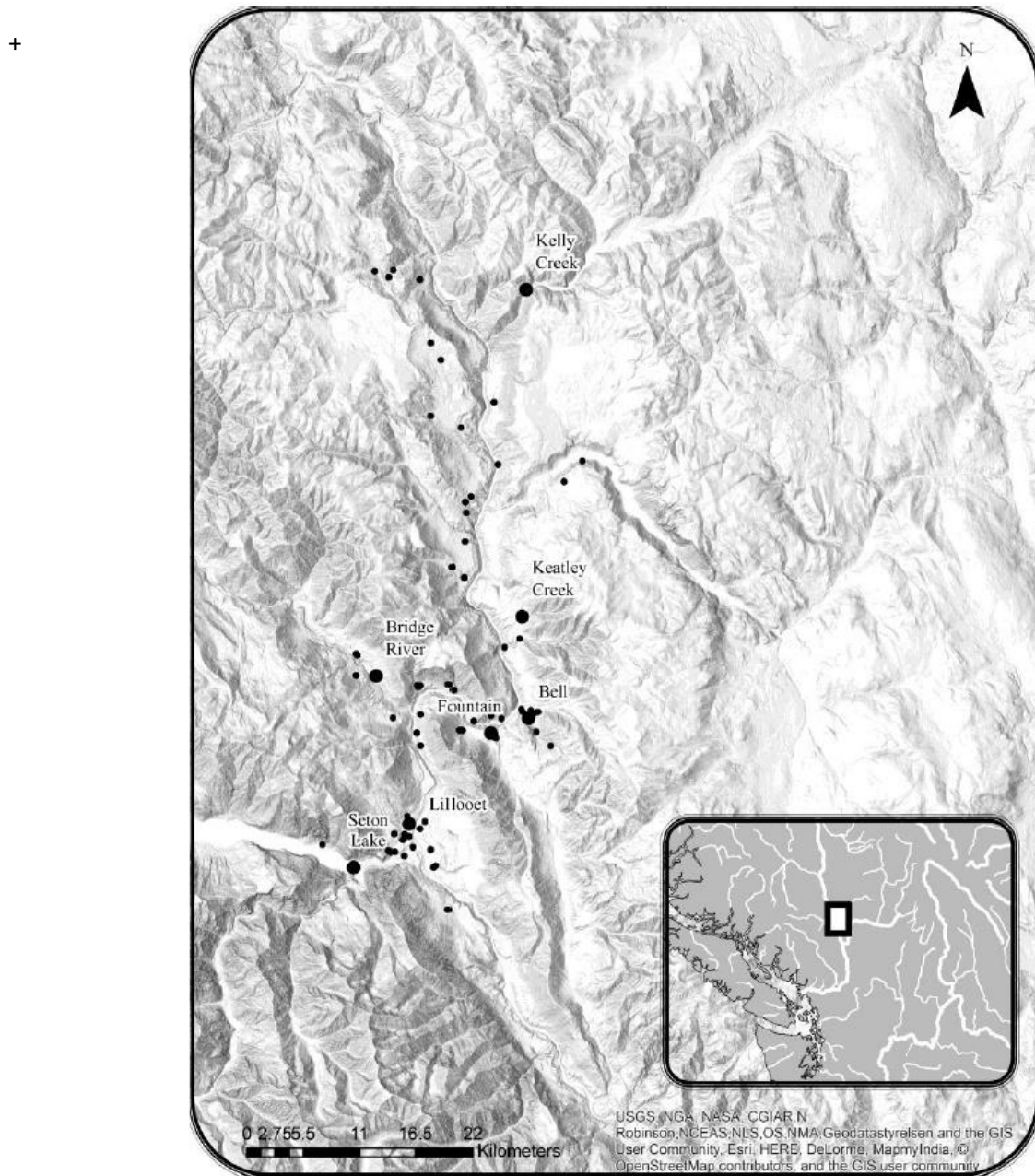


Figure 2.1. Overview of the Middle Fraser Canyon showcasing the Bridge River site alongside other nearby archaeological pithouse villages (Walsh 2015:3).

Over the past 11,000 years, climate changes have produced distinct ecological signatures. The following summarizes Plateau-wide changes: The warmest and driest conditions range from 11000 B.P to 9500 B.P., transitioning into a period of compact forestation as a result of increased precipitation during 9500 B.P. to 6400 B.P. Between 6500 B.P. and 4500 B.P., the general climate continues a warming trend, accommodating productive and large salmon fisheries. Wet conditions are sustained during 5400 B.P. and 2800 B.P. albeit cooler overall. Currently, the region undergoes warming and dry trends that had begun at approximately 2800 B.P. Compared to wetter periods, bunch grasses have replaced dense shrub steppe while forests have receded to higher elevations, seeking out more comfortable levels of moisture (Chatters 1988).



Figure 2.2. Aerial photograph of the Bridge River pithouse village (Prentiss and Kuijt 2012:104).

High biodiversity is present throughout the region. Salmonids are numerous alongside other anadromous species of fish, making it ideal for human groups who consistently rely on this distinct resource base. In the streams that connect with the larger riverine systems, several varieties of invertebrates such as crustaceans and mollusks thrive. Inland, there are over 300 species of bird including, but not limited to, grouse, raptors, and waterfowl. Eight ungulate species are present in the Plateau and adjacent regions: white-tailed deer, mule deer, elk, mouse, caribou, mountain goat, and pronghorn. These ungulates coexist with other mammals such as coyotes, wolves, beavers, brown and black bears, marmots, squirrels, and other rodents (Chatters 1998). Teit (1909) mentions that caribou, elk and moose were used by the Mid-Fraser peoples; however, these ungulates currently do not roam surrounding the valley, nor did they during Bridge River occupation periods (Prentiss, personal communication 2016). Teit (1909:77) suggests that elk were rare because they had been hunted to near extinction whereas moose and caribou thrived in higher latitudes.

Cultural Background

The Canadian Plateau region was historically comprised of intricate networks involving complex hunter-gatherer-fisher communities. An overview of the cultural chronology is derived from Rousseau's synthesis of the Canadian Plateau (Figure 1.1). Archaeological studies of the region have produced two distinct traditions divided into six descriptive units. The Nesikep tradition is composed of the Early Nesikep (ca 7000 BP – 6000 BP) and Lehman Phase (6000 BP – 4500 BP). The "Lochnore Phase" (pre 5000 BP) also falls within the Nesikep Tradition (5000 BP -200 BP (Prentiss and Kuijt 2004); although Stryd and Rousseau (1996) incorporated

Lochnore in the Plateau Pithouse Tradition (PPt), there are no known pithouses sites linked to this period. The PPt officially commences sometime after 4000 BP when Shuswap Horizon-based peoples moved up along the Northwest Coast and into Fraser Valley, replacing the inhabitants associated with the Lochnore Phase; this marks the Shuswap Phase (3500 BP – 2400 BP), leads into the Plateau Phase (2400 BP) and concludes with the Kamloops Phase (1200 BP – 200 BP) (Prentiss and Kuijt 2012).

The Plateau Pithouse Tradition (PPt) is named for its semi-subterranean and semi-permanent pithouses inhabited predominately during the winter seasons. Salmon fishing was a subsistence tactic of choice and intricate storage technologies and facilities were common. It is believed that the PPt lifestyle is best exemplified by ethnographic accounts of Interior Salish groups (Rousseau 2004).

Wet and cool climates defined the early stages of the Shuswap horizon circa 3500 BP. These environmental conditions accommodated high spawning rates for anadromous salmonids; it is no surprise that isotopic analyses of human remains suggest increased salmon consumption during the Shuswap (Chatters 1990; Prentiss and Kuijt 2004; Rousseau 2004). Semi-sedentism and delayed consumption practices became more and more prominent since the Shuswap horizon also marks the abandonment of practices such as residential group mobility and immediate consumption of gathered resources. Lithic raw material was acquired from local sources and housepit villages began to sprout (Rousseau 2004).

The Plateau Horizon transition occurs at 2400 B.P. The transition from Classic Collector strategy into Complex Collector system (Prentiss et al. 2005) found groups relying heavily on lithic reduction techniques, bone and antler technology, and succinct craft specialization such as the manufacturing of the bow and arrow. Village size continues to grow in

already established villages from Shuswap time. Often, these aggregate communities lie in close proximity with salmon fishers and floral resources. The Mid-Fraser region during late stage Plateau retains dense settlement patterns indicating ranked society. The argument for ranked society derives from evidence of extensive, prominent, and well-established exchange networks (Hayden 1997a, 1997b, 2000b; Hayden and Ryder 1991, Prentiss et al 2005). One such network was the trans-Rocky Mountain exchange network which allowed for high quality cherts, nephrite, argillite, dentalium and olivella shells to be traded and transported across the Plateau, Northern Plains, Eastern Kootenay, and Rocky Mountain Regions. In fact, Hayden and Schulting (1997) associated the appearance of domestic dogs in the archaeological record as an outcome of the “Plateau Interaction Sphere” (PIS), an exchange network which could have taken advantage of dogs as beasts of burden. Hayden and Schulting (1997) also argue that PIS originated out of ambitious, entrepreneurially-minded individuals; PIS could have been important for establishing elite classes that upheld trading responsibilities, thus contributing to the growth in complexity and the increase in inequality.

The Kamloops Horizon is similar to the Plateau Horizon, but is associated with a dramatic decline in upland plant resources and salmon populations. Increased variation in housepit floor plans is evident by the many structural shapes present during the period: oval, round, rectangular and square foundations that ranged between 5 to 22 meters in diameter (Rousseau 2004). The human population decline coupled with village abandonment could have been linked to salmon run stress since these fish were susceptible to over harvesting, long term droughts, and disease (Quinn 2005). Ultimately, the Kamloops horizon and the Plateau Pithouse tradition halted 200 years ago with the arrival of Europeans.

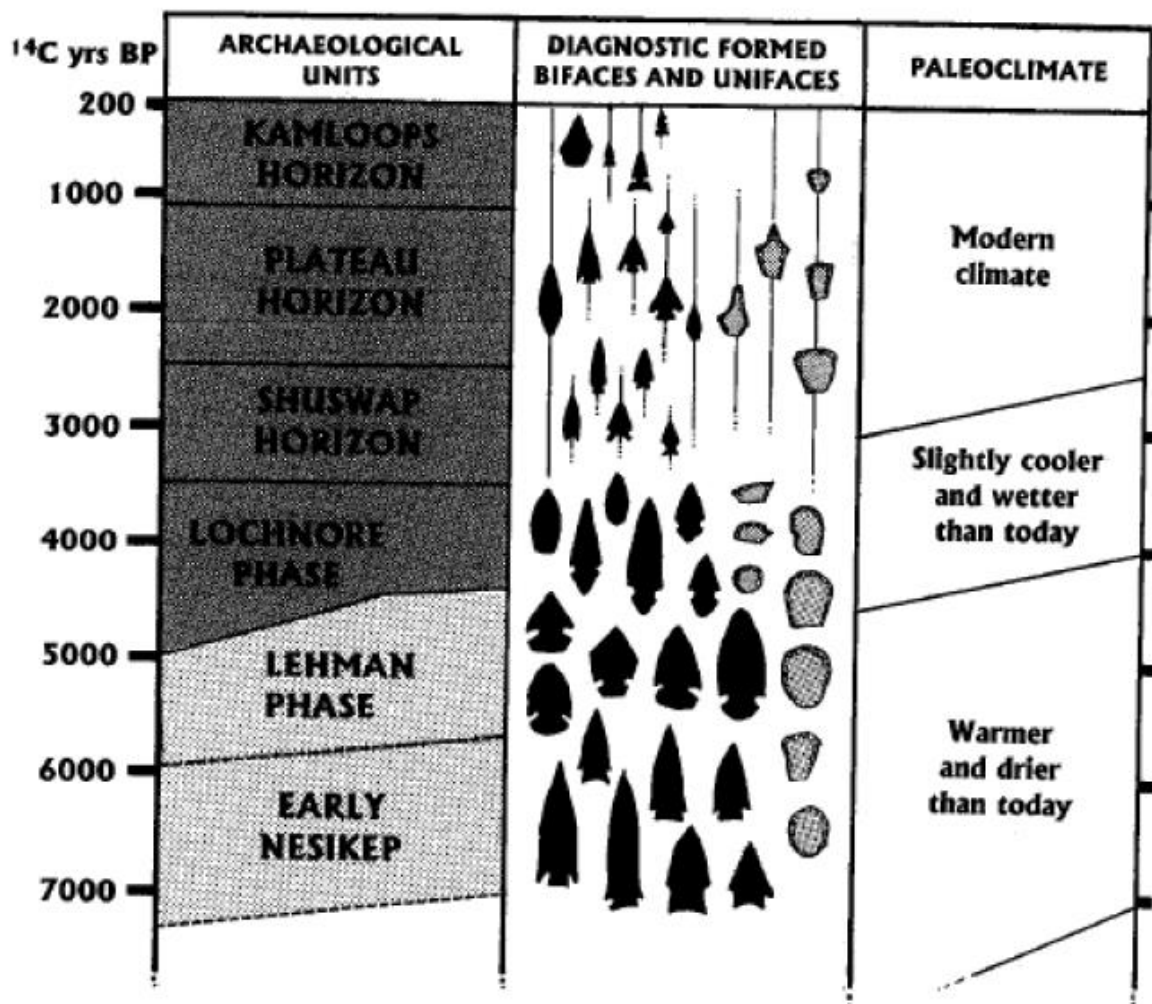


Figure 2.3. A Chronology for the Canadian Plateau (Rousseau 2004:10).

The Bridge River Site (EeR14)

The Bridge River village site (EeR14) consists of approximately 80 housepits, potentially having been segregated into two “neighborhoods,” a northern and southern half, as interpreted by Prentiss et al. (2008). Housepit 54 is considered to be a medium-sized for its kind. At 13.3m in

diameter, it includes occupations spanning the Bridge River Period 2 (BR2), ~1600-1300 B.P., through Bridge River Period 3 (BR3) at ~1300-1000 B.P., leading up to village abandonment. BR3 is believed to be the peak of Bridge River growth where there were 29 individual pithouses present at the time. After a long stretch of desertion after abandonment, humans eventually returned; some pithouses were reoccupied in 500-600 B.P. up to the Colonial Period (Prentiss et al. 2008).

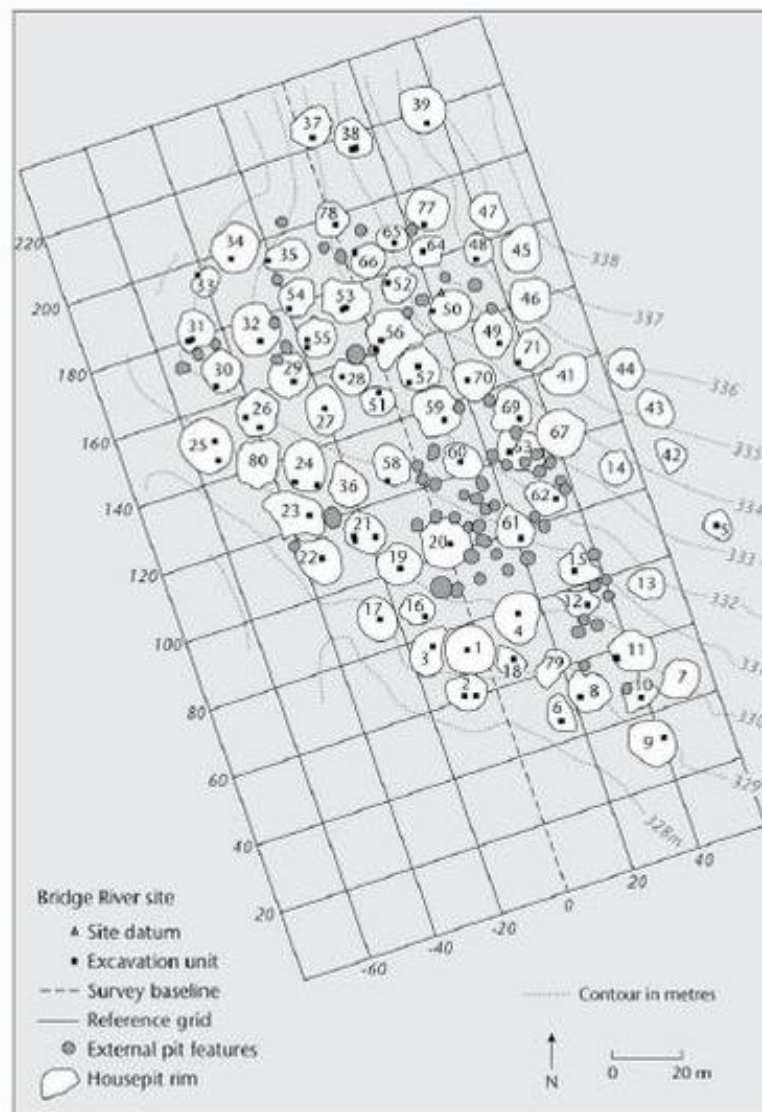


Figure 2.4. Map of the Bridge River site (Prentiss and Kuijt 2012:105).

Food Resources

Although awareness of the region's biodiversity is important for establishing context, it is also crucial to identify the exact resources that get incorporated within the diet of the region's inhabitants. Alexander (1992) lists terrestrial fauna used by Lillooet and Shuswap peoples: deer (*Odocoileus hemionus*), wolf (*Canis lupus*), coyote (*C. latrans*), lynx (*F. canadensis*), cougar (*Puma concolor*), red fox (*Vulpes vulpes*), marten (*M. americana*), mink (*Neovison vison*), muskrat (*Ondatra zibethicus*), fisher (*Martes pennant*), long-tailed weasel (*Mustela frenata*), short-tailed weasel (*Genus Mustela*), wolverine (*Gulo gulo*), elk (*Cervus canadensis*), moose (*Alces alces*), grizzly bear (*Ursus arctos horribilis*), black bear (*Ursus americanus*), long-tailed weasel (*Mustela frenata*), bighorn sheep (*Ovis Canadensis*), mountain goat (*Oreamnos americanus*), snowshoe hare (*Lepus americanus*), beaver (*Castor Canadensis*), porcupine (*Erethizon dorsatum*), red squirrel (*Tamiasciurus hudsonicus*), and the northern flying squirrel (*Glaucomys sabrinus*); this list is not exhaustive and other potential prey species could include, for example, geese, ducks and swans.

Turning to a prime ethnographic source, James Teit (1909:77) explicitly states that Mid-Fraser peoples subsisted on and relied upon “deer, elk, caribou, marmot, sheep, hare, beaver, grouse, bear, moose, duck, goose, crane, squirrel, [and] porcupine.” In the context of the early 20th century, moose, caribou, and elk were presumed rare; either as a result of overhunting and/or having their populations extensively controlled and regulated (Walsh 2015:29). Alexander (1992:53) argues that the dominance of deer offsetting the general elk population stems from climate trends. The growth of lowland trees and shrubs could have initiated deer and moose growth while simultaneously lowering salmon productivity. This dominance of deer in the

environment is also seen within the archaeological record. For example, past excavations at the neighboring Keatley Creek Site (EeR17) saw a mammal-oriented subsistence pattern that, through time, widened of the overall diet breadth of its habitants, eventually resulting in abandonment (Prentiss et al. 2007).

The Middle Fraser is a hotspot for Pacific salmon migration. As April rolls around, the appearance of Spring (Chinook) salmon initiates the first run of any given year; a second run happens around late May to early June (Kennedy and Bouchard 1992:272). Based upon studies from the 1960s and 1970s, Michal Kew (1992:190) found that Sockeye run from late June to early October and peaking around late August. Coho appear in mid- to late October and can extend well into November (Walsh 2015: 32). Although a myriad of factors affect long-term migration patterns, the recent satiability of late-Holocene climate may suggest that patterns currently observed today reflect general consistency within the millennia (Walsh 2015:33). Other than salmon, other aquatic resources utilized by the Mid-Fraser peoples include bivalves; ethnobotanist Nancy Turner confirms the harvesting of the western pearlshell (*Margaritifera falcata*), western floater (*Anodonta kennerlyi*), and winged floater (*Anodonta muttalliana*) (Alexander 1992:89).

Resource Availability

Salmon productivity is heavily dependent upon given environmental conditions. Salmon migration patterns are affected by water temperature, flow strength, changing depths, and the appearance or reappearance of waterway obstructions. For example, drought conditions in the Fraser during 1998 resulted in significantly lower than average Sockeye populations migrating

through the drainage for that given year (Macdonald et al. 2000). Both subtle and drastic changes can result in dramatic outcomes, thus making it especially difficult to model variation in salmon availability in a prehistoric context; this is especially true given that Prentiss et al. (2005, 2011) argue that the Interior Plateau experienced periodic instability throughout the late Holocene. The emergence of Middle Fraser Canyon villages coincided with warm and dry conditions that transitioned into more moist climates resulting from the Roman Warm Period ending ~1600 BP; it is this climatic episode which would have brought greater fisheries production. Not surprisingly, the Middle Fraser village complex faltered during a decrease in productive salmon habitat likely associated with cooler temperatures of the Little Ice Age (Walsh 2015:35).

Ungulates were also important in the general Bridge River diet, especially when salmon availability was miniscule either due to a non-migration months or relatively unproductive years. Although important for protein, ungulates also provided sinew, antler, bone, and hides that can be manipulated to signal social prestige, especially between hunters (Romanoff 1992b; Teit 1906). Both salmon and deer meat was air-dried or smoked, later to be placed in storage, eaten, incorporated in feasting events, or traded (Romanoff 1992b).

As reiterated in previous research, resource availability has strong ties to complex hunter-gatherer demography. This project aims to consider how these dynamics affect human population shifts. Dogs are especially important because, as with their human counterparts, they are also actors within these dynamic contexts. I will now discuss dogs' roles within previously discussed environmental and cultural contexts.

Dogs of the Interior Plateau and the Pacific Northwest

Brian Hayden's excavations at the Keatley Creek site attempted to reconstruct ancient social organization between housepits by exploration floor size and availability in subsistence, storage, and prestige goods (Prentiss and Kuijt 2012:161). Of particular interest is Housepit 7, one of the larger houses with substantially more storage space compared to other dwellings. Hayden interprets Housepit 7 as an example of a relatively wealthy household, one that had greater access to surplus food and nonfood goods. Variability in hearth-centered areas of Housepit 7 could imply that different groups are represented in different sections of the house. For example, the "south group" hoarded the largest quantities of mammalian bone. A particular type of mammal in great quantities was present in the center: dogs.

Hayden's crew uncovered an intact dog skull alongside a cluster of dog bones within a cache pit which predated the final floor by about 500 years. David Crellin's (1994) zooarchaeological analysis proposes that the dogs had been killed via a blow to the head rather than being butchered. Evidence of postmortem gnawing by other canids is also visible. Hayden argues that dog remains at Housepit 7 reflect ritual sacrifices similar to that of Siberia's Koryak. The Koryak are known to have killed dogs with blows to the head; later, they would hang the deceased canids on poles for a period of time until the flesh is removed, later to be placed within the home. Another interpretation of dog remains of similar contexts was made by Crellin (1994) who suggested that canids that were selectively killed off were considered to be a nuisance. Rim deposits contained bones with cut marks, further implying their role as a food item (Prentiss and Kuijt 2012:165). Cail (2012), on the other hand, suggests that dog bones are physical remnants of the feasting apparatus and the development of prestige economies. Overall, there is potential for understanding the degree of variability to which dogs were utilized in Middle Fraser Canyon. To

further discern and validate the interpretation of variability, past scholars have heavily relied on ethnography and ethnohistory; this project aims to do so as well.

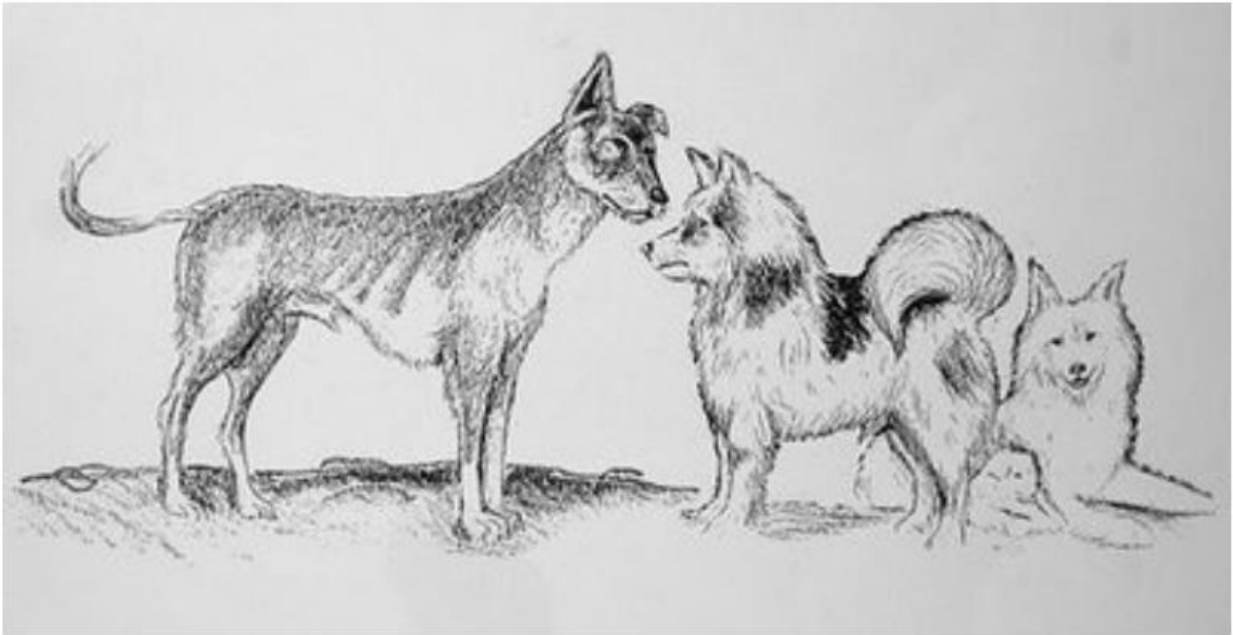


Figure 2.5. Archaeo-forensic reconstruction drawings of the western North American village dog (left) and the Salish Wool dog (middle and right) by Pye (Crockford and Pye 1997).

The Pacific Northwest is known for its bountiful supply of timber and salmon, making it a unique region known for its complex hunter-gatherers and their dogs. A highly stratified society was unusual compared to the rest of the continent. Despite the absence of agriculture in the Northwest Coast, hereditary nobles, commoners, and slaves existed, bounded together by elaborate and artistic displays of prestige: totem poles, war canoes, and impressive plank houses (Schwartz 1997:34). For the Nuu-chah-nulth, dogs were the epitome of household wherewithal, kept “for no particular reason except that the animals managed to survive and preferred human company to competing with wolves in the woods. Only rarely did the animals serve any useful purpose” (Drucker 1951:109). Although dogs as sole reflections of household wherewithal is not representative of First Nations groups within the Middle Fraser River Canyon prehistory, canidae

have qualities that make it the most likely candidate for domestication. Canids are not too large, highly submissive to humans, and are arguably the most predisposed towards people compared to other domestic animals prevalent in modern society (Wang and Tedford 2008:166). Dogs are considered mesocarnivores: able to consume a diverse array of foods. Thus, they are known to scavenge, scouring anthropogenic trash dumps for leftover food (Wang and Tedford 2008:166).

The Makah and Coast Salish peoples of the south central Northwest Coast of North America (southeastern Vancouver Island, northern Olympic Peninsula, the Gulf Islands, Puget Sound and the Fraser River Delta) kept two types of dogs (*Canis familiaris*): the medium-sized “village” dog and the shorter but with thicker and soft fur “wool” dog. Both early historic and ethnographic accounts reveal that “wool” dog fur was extracted and woven into blankets (Crockford 1997a:1). Ethnographic accounts and speculations (Teit 1900, Crellin 1994, Hayden 1997, Carlson 2010) also suggest that the treatment of prized hunting dogs and/or “wool” dogs were superior to that of “village” dogs. The two breeds were deliberately maintained separately, possibly because it prevented interbreeding since the two types were exploited differently (Crockford 1997a:102). In terms of village organization, perhaps the breeds were kept separate from one another due to their distinctive roles that can be interpreted from the archaeological record. For example, Cail (2011) suggests that a hunter would have a proper burial.

Hunting with Dogs

Teit’s (1906:226) account of the Lillooet dogs:

“Dogs were extensively used for running down deer and bear... Trained hunting dogs were taken good care of. Some men washed them regularly, purged them with medicine, and even wiped and cleansed their noses.”

Dogs of the Mid-Fraser were deployed during both small game and large game hunts; these include but were not limited to deer, caribou, elk, bear, and beaver (Teit 1909:782-3). Teit observed different hunting techniques. For example, the Shuswap would let their dogs loose, driving deer to large bodies of water, oftentimes rivers. The Shuswap would then pursue the deer via canoe, drowning the deer by attaching their long sticks with a crook to their antlers and pulling them underwater (Teit 1909:521). Another popular method involved driving deer into “deer fences” where the use of dogs has been recorded with other Plateau groups (Crellin 1994:16). Hunting dogs of the Southern Okanagan were given great care and were bred with the best males. According to Post (1938), puppies were placed in holes, and those strong enough to climb out and escape were kept. Desired hunting dogs were worth a half a dozen deer hides and a single buffalo skin (Post 1938:33). On the other hand, Teit’s (1900) account of the Lillooet states that a good hunting dog was traded for large dressed elk skin in Kamloops at the Hudson Bay Company Trading post (Cail 2011:21).

Dogs enhance the efficiency of hunting in multiple facets. Shimek (2014:4) identified broad categories of hunting activities that are unique to dog-use; her classifications stem from the work of Fiedel (2005), Koster (2008), and ethnographic accounts. *Tracking* involves the scenting and sighting of prey in direct visual contact or those well hidden in dens, burrows, nests and other environmental living spaces. “*Flushing* is the act of disturbing a prey animal from its hiding spot so it can be seen and pursued by human hunters” (Shimek 2014:4). *Driving* is the act to which canids run their prey into exhaustion, perhaps herding them into traps or a human ambush. *Subduction* is the capturing of prey, keeping the animal confined and immobile so that the hunting band or individual can locate the prey and make the final kill. *Dispatching* is simply

the act of killing of the prey without assistance. Lastly, *retrieving* involves locating, killing, and the bringing back of prey animals to the hunting band or individual. Overall, the efficiency in dog deployment can be traced to the initial, middle, and ending stages of a devised hunt. One account by Robert Stuart of the Pacific Fur Company described a detailed scene at Astoria in 1812:

“Their general mode of hunting elk and deer is with the bow and arrow, very few possessing or knowing the use of Fire Arms; they frequently go in large parties, surround the game while grazing in a favorable place, such as a small prairie or meadow environed by wood; they plant themselves in the different avenues, or paths leading to this spot, then set in their dogs, which throws the affrighted animals in such confusion as to scatter in every direction, thereby giving the most or all a chance of exercising their skill, for let the consternation of these poor creatures be ever so great, they can only escape by those leading paths” (Stuart 1995:14).

Dogs Consumption

Dogs are consumed in different contexts, oftentimes a reflection of longstanding traditions linked to particular groups. Canids can be: 1) surplus; 2) a staple food; 3) an actor in well-defined taboos (Snyder 1991). Teit writes that the Lillooet ate dog flesh extensively when compared to the Thompson and the Shuswap (Teit 1906, 1909). Therefore, Lillooet utilized dog as husbanded sources of protein whereas the Thompson and Shuswap only consumed canids during famines (Crockford 1997b; Snyder 1991). Despite the slew of ethnographic accounts, the practice of dog consumption and the taboos that come with it are not fully understood, especially when Teit does not differentiate between the Lower or Upper Lillooet; the Lower Lillooet were in close trading contact with the Northwest Coast peoples, people who considered dog consumption distasteful (Crellis 1994:25). The strict taboos and practical sanctions related to dog

consumption in the region are relatively unique when compared to dogs' role in other non-industrial societies. For example, the historical Pawnee groups of North America would eat dogs as a staple source of protein in the villages; they were also regarded as emergency surplus during long hunting trips (Bozell 1988).

In a purely caloric standpoint, dogs are advantageous as a food resource. Like other husbanded resources, they provide calories, protein, and nutrients as long as they are kept alive. What makes them differ from heavier cattle is their ability to move freely and easily; they are able to sufficiently follow and traverse with mobile peoples. As a result, dogs are sufficient enough for short-term trips during hunting or raw material acquisition (Shimek 2014:8). Several ethnographic accounts report that the consumption domestic canids are the result of resource use scheduling. For example, the Omahas would predominately eat dogs during the spring season when other food resources were scarce are virtually unavailable (Snyder 1991:361).

Beasts of Burden

Dogs were likely to have been incorporated into intricate subsistence systems which required seasonal movement in varied landscapes. Dogs were called *K'usik'usi* in Ichiskiin, the "Northwest Sahaptin" language spoken by multiple middle Columbia groups of the early 1800s; the word literally translates to "little horse" (Kuykendall 1889:73). Horses, on the other hand, were initially named as "big dogs" via other Native languages throughout the American west (e.g. Thompson 1962:330; Weltfish 1965:143). It is this overlapping "big dog, little horse" dichotomy which suggests that both animals acted as beasts of burden, four-legged companions that operated as transport mechanisms within an overarching economy. Mack (2015) argues that the recorded Lewis and Clark expeditions during the early 18th Century clearly reinstated horses

as the primary beast of burden of choice during the 1805 and 1806 years. Despite this observation, Lewis and Clark continued to purchase surplus dogs along the middle Columbia from people who lived predominately sedentary lifestyles, in semi-permanent villages, and those that travel frequently with horses.

The Archaeological Implications of Dogs

The recovery of dogs in archaeological contexts has been frequent; as such, canid remains have been placed in the forefront of archaeological inquiry, interpretation, and general curiosity. As discussed earlier, ethnohistory provides substantial foundation for dog usages in different cultural group contexts. Moving towards an archaeological framework for interpreting dog use, there needs to be valid measurements, tools, and theoretical foundations which fully comply with the requirements that uphold scholarly legitimacy.

Large canid remains recovered from sites throughout the Great Plains sparked academic interest in studying dogs as a food resource. Thomas E. White was one of the first scholars to notice evidence of canid butchering in Plains groups. He saw different frequencies of canid skeletal remains as indicators of variation in cultural and ethnic entities as well as the patterning of carcass dismemberment (White 1952, 1954, 1955). For example, the lack of proximal humeri could be an indication that the front limb was broken off via the striking of a hammerstone, particularly aimed at the humeral head. White's (1955) zooarchaeological study treated dog remains similar to how bison and antelope would have been analyzed in a butchering context. He concluded that:

“It would appear that the dietary role of the dog was probably equivalent to that of fried chicken in the rural diets before the days of electric or kerosene ice-boxes—that is for a special feast, or an occasional meal of fresh meat, or ceremonial feasts” (White 1955:170).

Crellin (1994:91-94) created six categories of cultural relationships of domesticated dogs that can be teased out archaeologically: “Ritual (Sacrifice and Feasting),” “Protection and Companionship,” “Food Resource,” “Transportation,” “Hunting Activities,” and “Clothing.” These categories will now be summarized. Canid skeletal remains in association with ritual should not be randomly distributed within a household context. Rather, they have peculiar placement with specific features (i.e. burial pits), sometimes with unusual elements represented. Although signs of processing may be present, it could be unique to butchering primarily for subsistence. Canids that fall within the “Protection and Companionship” category have similar archaeological implications to ritual-based dogs, but also include the possibility of inclusion with human burials and signs of death by natural causes (i.e. without signs of processing). Dogs as a “food resource” will have undergone the same processing treatment as other faunal resources; their elements will be scattered and distributed randomly or sometimes mixed with other food remains. Other “food resource” evidence include cut marks that suggest butchering (i.e. ligament and muscle attachments), death at a young age, and evidence of burning, especially when near hearths. “Transportation” canids are typically older (high valued and kept into maturity) and may have skeletal pathologies that pinpoint to physical stress, such as Osteoarthritis. Evidence for dogs involved in “hunting activities” is the most difficult to assess; they may be involved in deliberate burials or showcase signs of trauma related to hunting activities. Lastly, “Clothing”

dogs, those exploited for their skins, should have cut marks that differ from patterns related to animals butchered specifically for meat and consumption.

These test expectations summarized by Crellin (1994) have explicitly shown that dogs in the archaeological record exhibit high degrees of complexity that can be teased out in the micro-scale. A zooarchaeological study by Cail (2011) of Bridge River's Housepit 24 examines the visible signs of trauma and cut-marks on individual elements alongside spatial contexts. The Cail (2011) thesis was able to interpret one particular role of dogs, particularly as a feasting apparatus. Although the roles of dogs at HP 54 are to be interpreted in this project via statistical approaches rather than formal zooarchaeological methodology, the ultimate goal is to decipher the degree to which dogs are incorporated in the household economy. For example, if dogs were in fact assigned as a food resource, how did this assumed role affect the general faunal assemblage archaeologically?

CHAPTER 3 THEORY

Dogs are complex in the archaeological record; there are high degrees of variability in how they interact with other forms of archaeological data. As evidenced in ethnohistory, dogs uphold a variety of roles ranging from acting as a food resource to providing loyal companionship. These roles may be assigned due to preexisting traditions or taboos emplaced, or they could be a reflection of ever-changing cost-benefit household goals and needs. Whether canids provide companionship or surplus calories, they exist to be exploited for benefits. Thus, it is logical to frame this study under human behavioral ecology since: 1) we can see change through generational time; 2) testable “cost-benefit” hypotheses are formulated by hypo-deductive logic.

Human Behavioral Ecology (HBE) explicitly identifies decision making processes as a reflection of adaptation and natural selection processes that are governed by given environmental conditions. Via management of energy usage, often in terms of caloric cost-benefit frameworks, HBE questions the logic behind selecting different pathways of adaptive decision making; certain decisions result in expenditure of a large sum of energy, yet do not produce beneficial outcomes and vice versa.

Anthropologists that incorporate HBE in their research aim to identify variability in the ways humans behave within different environmental contexts. Through modeling, evolutionary ecologists examine how fluctuating populations, “competitive equilibria” or “diversity in the community determine processes that govern certain behaviors and trends (Bettinger 1991:5). The general assumption is that social and political behaviors are driven by basic economic features that govern the lives of hunter-gatherers (Winterhalder 2001). HBE allows for the testing of

hypotheses related to different levels of hunter-gatherer production because it is possible to examine specific functions regarding exact socio-ecological variables: x, y, and z (Winterhalder 2001:33).

Cost-benefit research questions asked within HBE frameworks are possible via Optimal Foraging Models. Subsistence needs alongside available surrounding resources affects how humans react to their surrounding environment – a means of adaptation (Broughton 1994a). Thus, human behavior is a reflection of how people exploit their environments. Due to the complexity of these environments, HBE assesses how specific conditions are diagnostic of specific adaptive decision-making strategies within varied contexts. It is the characteristics of these environmental “arenas” that dictate the specific kinds of decision-making strategies necessary for human survival (Winterhalder and Smith 1992). Optimal Foraging theory aims to determine how different variables within varied environments can alter human behavior.

Optimal Foraging Theory (OFT) assumes that the forager has the intention of maximizing overall net return which, in turn, maximizes fitness. Models derived from OFT allow researchers to predict the types of resources most likely to be pursued when encountered (diet breadth), which areas foragers choose over others for their resources (patch choice models) and the length of stay within these areas (marginal value theorem). Both qualitative and quantitative tests can be applied to these models. For example, in regards to the diet breadth model, qualitative tests can assess the choices of prey most likely to be pursued upon encountered depending upon profitability (Winterhalder and Smith 2000). Quantitative tests implemented in diet breadth can determine the exact number of species pursued by a forager within specific environmental conditions (Kaplan and Hill 1992).

Nutritional Modeling

There are numerous HBE-grounded models and methods that are pertinent to canid ownership, such as nutritional modeling. Energy as a form of currency (kcal/unit of measure/per unit of time) has been a predominant socio-ecological variable for testing optimal decision making-based hypotheses. Otherwise known as “nutrient currencies,” anthropologists who work within the HBE framework are notorious for counting calories, quantifying energetics as a means to test different hunting-gathering scenarios in order to tease out human behavior, a “product of simple rules played out in an exceptional complex environment” (Winterhalder and Smith 1992:8). Since this project is developed in a “cost-benefit” framework, it examines the dynamics between spending nutrient currency and gaining nutrient currency. Under optimal decision-making, the assumption is that kcal/unit spent is for the sole purpose of gaining kcal/unit profit in the long-term: Does canid maintenance and ownership provide such positive outcomes?

From the start, the abundance of archaeological findings reflecting dietary habits of past peoples stirred scholarly curiosity in modeling nutritional gains and benefits. White (1953), for example, multiplied the MNI (minimum number of animals per species) by estimated edible meat weight related to each species, quantifying diet in relation to biomass. Despite the method being heavily debated (e.g. Casteel 1974, 1978; Binford 1981), White creatively attempted to tease out energetics knowing that the archaeological record generally does not preserve the meat itself. A few decades later post-White, Wing’s (1978, 1984) investigation of dogs in the Vecracruz sites of prehistoric Middle America found that dogs were managed food supplies as a reaction to fluctuating aquatic-based food resources. Wing declared that the incorporation of canids in the diet accommodates environmental cycles. Seasonality coupled with resource

oscillations within the Bridge River Canyon could hypothetically be reflected in the canid record, assuming that dogs were utilized as either hunting dogs and/or edibles.

Seasonality not only affects the availability of certain resources, but the cumulative fat content of these resources as well. Ungulates and other game during winter and early spring experience food-related stress due to the lack of grasses for consumption. As a result, ungulates must conservatively rely on stored fat and energy to survive until the snow thaws (Snyder 1991:371). Wildlife biologists have closely monitored how these fluctuating body-fat levels are oftentimes associated with health status. For example, Speth and Spielmann's (1983) study of antelope (*Antilocapra americana*) produced data suggesting that ungulate fat reserves can drop to less than 2 percent during periods of intense nutritional stress. Domesticated dogs at Bridge River must have yielded high caloric costs since they either expend lots of energy or must accumulate a high enough fat content to be calorically justifiable as husbanded food.

Central Place Foraging Model

The Central Place Foraging Model assumes that the forager will optimally choose to transport resources of the highest utility back to the "central place" (base camp) with distance being a factor. Achieving the highest payoff in relation to effort spent is the goal (Bettinger et al. 2006; Bettinger 2009; O'Connell et al. 1988; 1990). If there is more effort required for transport, then utility-driven decision making will govern whether the hunter-gatherer is selective in her resource choices or how she tactfully increases the utility of the given resource. For example, if a deer is killed far from the village, the hunter will assess the current situation and can likely

undergo field processing, consciously choosing to haul back parts of the carcass that are meatier (higher-utility) while leaving behind parts of lower-utility.

If dogs were tactfully deployed in hunts as a means to raise resource-utility, it is expected that the use of hunting dogs will be more prominent during instances when prey is scarce and typically sought after in distances beyond the general Bridge River foraging radius; and if this were the case, then dogs should be more prominent in housepit floors that archaeologically showcases evidence of selective processing—that is, skeletal elements that were the “meat-rich” portions of carcasses. The transportation of muscle-rich appendicular elements should then be more representative compared to axial counterparts. In contrast, in instances where large prey is more readily available nearby, we should expect to see fewer dogs alongside higher frequencies of axial elements. The specifics regarding axial and appendicular elements will be further explored in a later section of this manuscript. It is worth noting that these broad test expectations are riddled with assumptions and generalizations. For example, even if dogs were more commonly deployed during hunts during episodes of resource depletion, does the archaeological record dictate an immediate increase in pack size?

The Hauling Model

The hauling model was created by Shimek (2014) and was conceptualized as a conditional function, taking into account kilocalories as cost-benefit currencies in different contexts. As mentioned by Crellin (1994) and Cail (2001), it is possible to assess the perimortem fractures and evidence of trauma linked to osteoarthritis; the goal is to interpret how dogs were either butchered or used for transportation. The hauling model attempts to model dog usage for

carrying goods in bulk; in the Bridge River context, this could either be carcasses from hunting ungulates or fish from the river. There are two curves: benefit and cost. The benefit portion of the equation is plotted separately so that, if benefit is greater than cost, it is optimal to utilize dogs for hauling-related tasks (Figure 3.1). The benefit variable (B) is defined as the kilocalories saved when using a dog to haul materials rather than have a human individual exert their own calories to haul the same weight. The model also takes into account the mass of a single canid; a dog's body mass ultimately determines the maximum amount of mass/weight that dog can carry (w); Shimek (2014) sets this standard to one-half of the dog's body mass. This standard has been derived from ethnographic sources (e.g., Harmon 1957; Kurz 1937) where the maximum carried is one-half of the carrier's weight. Although contemporary dog-packing enthusiasts recommend the max to be 15% to 30% of a dog's body weight (Shimek 2014), this study opts to override these conservative estimates in favor of the ethnographic accounts.

$$\begin{aligned} \text{If } n \cdot w \leq g, \text{ then } B &= (n \cdot w \cdot t \cdot H) - (n \cdot c \cdot f) \\ \text{If } n \cdot w > g, \text{ then } B &= (g \cdot t \cdot H) - (n \cdot c \cdot f) \end{aligned}$$

B = caloric savings to person using dogs to haul
 m = mass of the dog
 w = amount one dog can haul = $m/2$
 g = total amount needing to be hauled
 t = distance needing to be traveled
 H = caloric hauling cost to dog per unit weight per unit distance
 n = number of dogs
 c = caloric cost to feed one dog for one day
 f = cost per calorie of dog food

FIGURE 3.1: The Hauling Model (Shimek 2014).

The justification is as follows: since the model grounds itself in human behavioral ecology, the project seeks to determine the less costly, most beneficial decision-making tactic. Variable H examines the caloric cost in relation to the unit of mass associated with a single unit of distance. In other words, variable H takes incorporates energetic costs as it relates to variability in dogs' hauling ability, whether it is affected by situational terrain or weather conditions. Lastly, other variables discussed include the following: “n (number of dogs), c (caloric cost to feed one dog for one day), and f (the cost per calorie of dog food)... total mass or weight to be carried (g) and the total distance to be traveled (t)” (Shimek 2014:13).

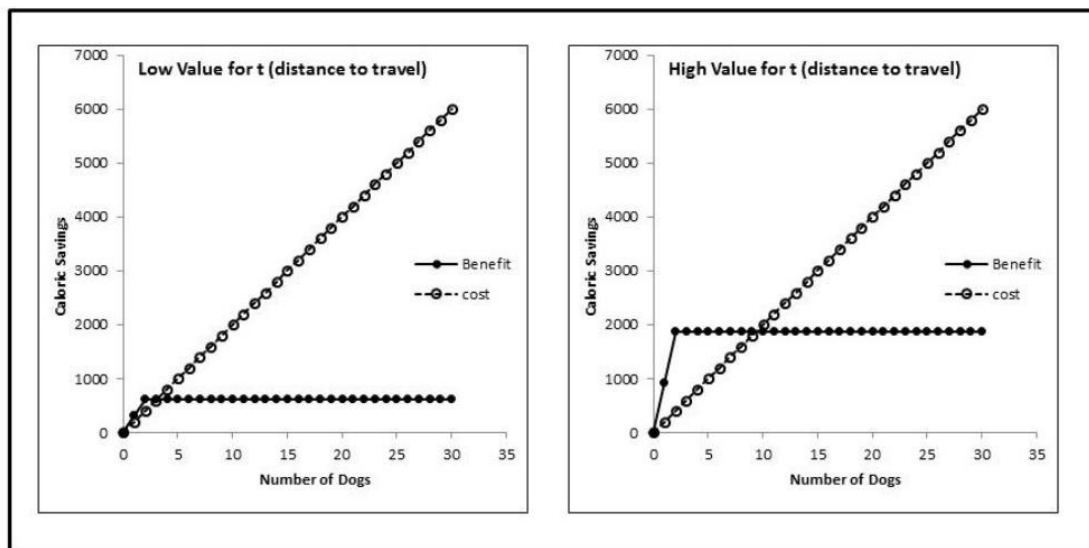


FIGURE 3.2: Behavior of the Hauling Model taking into account total amount needing to be hauled (g) with other variables being held constant. Left: lower number of dogs results in minimal benefits if g is a low value. Right: higher number of dogs results in higher degrees of potential benefits assuming that g is high (Shimek 2014).

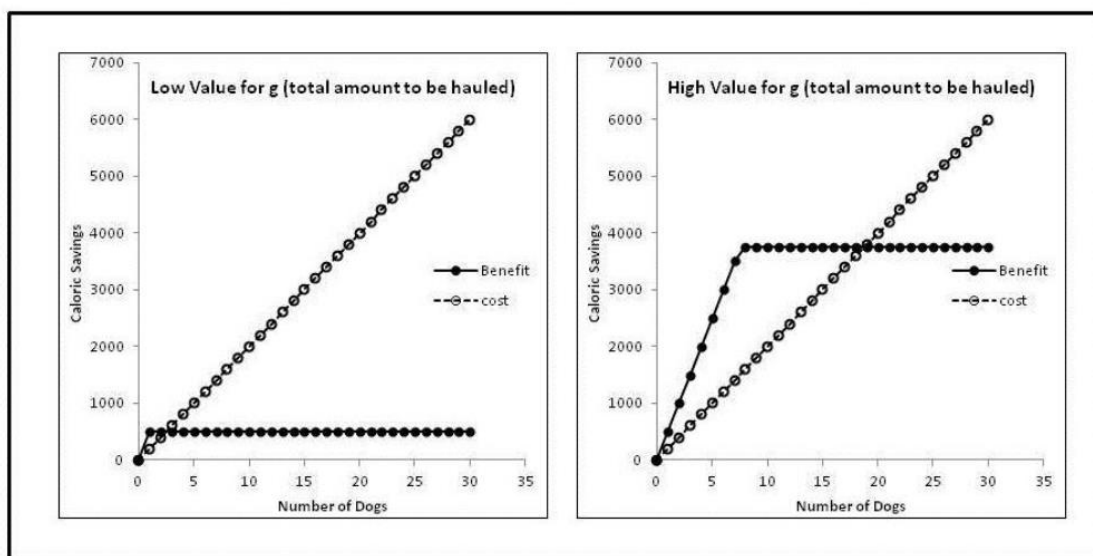


FIGURE 3.3: Behavior of the Hauling Model taking into travel distance (t) with other variables being held constant. Left: lower number of dogs results in minimal benefits if t is a low value. Right: higher number of dogs results in higher degrees of potential benefits when farther distances are required (Shimek 2014).

Canids exhibit dog-related costs that complicate optimal foraging analyses. As the Shimek (2014) models explicitly showcase, dogs are either beneficial or costly depending on the nature of three concurrent elements: 1) the context of available resources (i.e. resource depression versus resource rebound); 2) specific hunting strategies deployed by dogs' human counterparts; 3) dog upkeep costs. In regards to how dog-related costs differ depending on fluctuating resource availability, this can best be examined via the logic underlying the Central Place Foraging model: in times of resource stress, appendicular elements (meatier) will be more prominent compared to axial elements (bonier), with the assumption that higher frequency of limb bones are to be expected in times where there is selectivity in the choices of parts to be brought back to camp due to high travel costs. Thus, dogs should be incorporated during hunts more frequently in times where traveling farther distances is required to achieve minimum caloric requirements in the household level. In regards to acknowledging the specific strategies for dogs during hunts, this is much harder to read in the archaeological record. The following

inferences can be made, however: Under episodes of resource depression, it is costly to own too many dogs due to amount being hauled being lower than average, but it is still beneficial to own dogs if travel distance is high (Figure 4.3). Lastly, the cost of feedings dogs *is* expensive. Under the Shimek (2011) logic, it would then be best to keep the least amount of useable dogs possible (Figure 3.5); however, this discrepancy may best be explained by costly signaling theory, which will be further discussed.

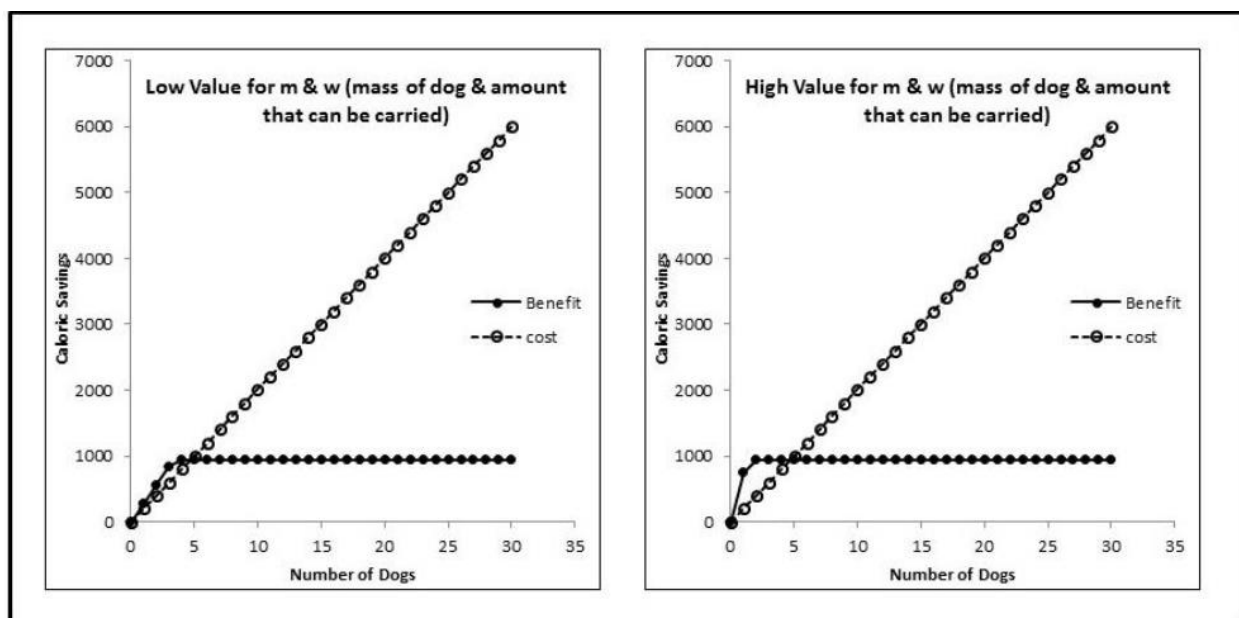


FIGURE 3.4: Behavior of the Hauling Model taking into account the mass of the canid (m) and amount that can be carried (w) with other variables being held constant. Left: owning low number of dogs would achieve caloric savings if m and w are low. Right: if there is a high m and w value, owning higher number of dogs would not increase benefits (Shimek 2014).

Seeking out the variability in the contexts to which dogs are deployed as hunting aids can best be read through case studies. Koster's (2008) study of the indigenous Miskito and Mayangna of Nicaragua presents dogs a "trade-off" strategy: increased encounter rates for specific prey species while increasing overall pursuit rates. With aboriginal Taiwanese hunters

increasing wild boar (*Sus scrofa taiwanus*) encounter rates (Nobayashi 2006) or the reduction of gemsboks and duikers handling times for the Kalahari (Ikeya 1994), the theme is clear: usefulness, costs, and benefits of dogs as a whole varies at different sites.

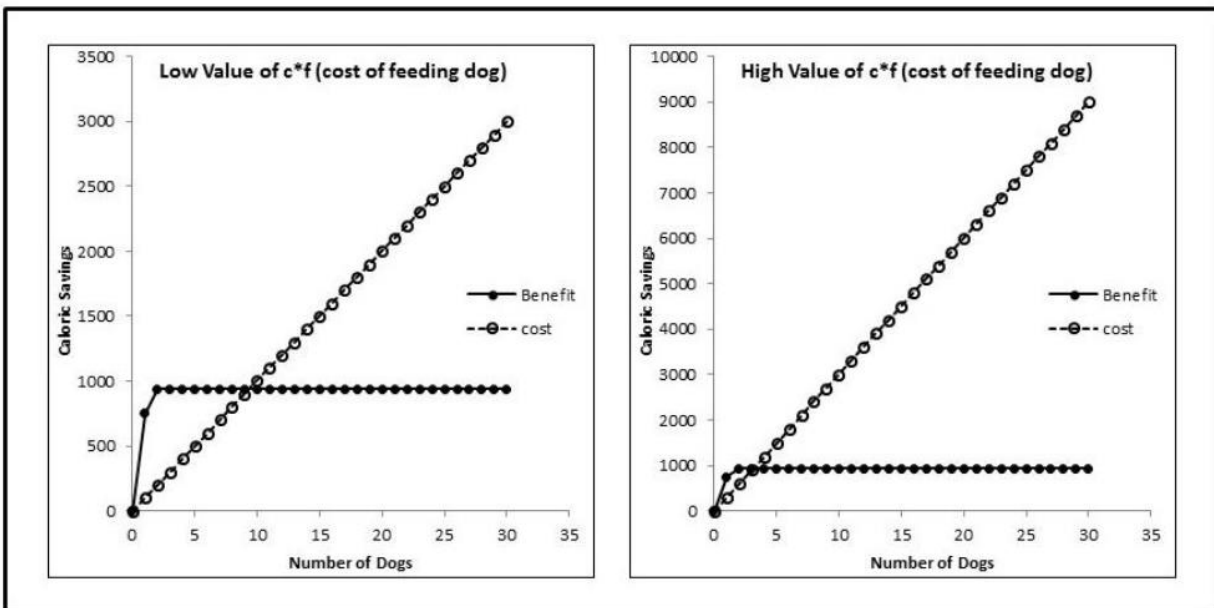


FIGURE 3.5: Behavior of the Hauling Model varying the cost of feed while examining caloric need and cost of procuring dog food (f) while holding other variables constant. Left: high amounts of benefits are acquired if $c \cdot f$ is low and large pack sizes are maintained. Right: if $c \cdot f$ is high, small amounts of benefits are achieved only if small pack sizes are maintained (Shimek 2014).

Costly Signaling

If retaining dogs is expensive in the long-term, why bother with upkeep? This phenomenon may be best explained under the alternative explanation for “economically irrational” decision-making: costly signaling theory (CST). CST aims to explain two major paradoxical observations prevalent in many hunter-gatherer case studies summarized by Bird et al. (2001:10): “the persistence of wasteful phenotypes when natural selection is assumed to

create greater efficiency, and the evolution of honest communication despite the pervasive conflicts of interest underlying evolutionary processes” (Getty 1998; Johnstone 1997; Zahavi 1975, 1977). Separate individuals or groups’ interests are preserved via communication of conflicting interest. Thus, mutual benefits are maintained for both the signaler and the observer as long as both parties are honest, “even when signaler and recipient are antagonists or competitors” (Bird et al. 2001:10).

CST is applicable in explaining a myriad of events and practices within a hunter-gatherer context. Hawkes (1990, 1991), for example, explores the “show off” model in which the practice of hunting may have manifested into a form of status competition between individuals with the general surrounding public being the audience (the recipient of the signal). Bird et al.’s (2001) study of hunting and spearfishing practices of the Melanesian Meriam peoples presents the practice of turtle hunting occurring predominately in feast contexts; it is suggested that the act itself is costly due to little signaling potential with benefits being primarily nutritional. However, displays of generosity between neighbors via sharing, the Merian ethic of *debe tonar*, could be interpreted as a valuable signal that could reap long-term benefits. For example, feast-goers are aware of hunters’ identities, but not those of jumpers who technically also play a role in the turtle hunting process (Bird et al. 2001:13). In another case study, Sosis (2000) argues that CST best explains why Ifaluk men take part in energetically inefficient fishing methods in order to fulfill the necessary steps for ritual preparation.

The practice of canid ownership at HP 54 may have been driven by additional factors related to motivational and evolutionary significance. Exclusively feeding dogs salmon may seem economically “wasteful” on the surface level, but could be the social and political signaling benefits that compensate for the overall cost, much like how Veblen (1899) explains both

“conspicuous leisure” and “conspicuous consumption” of material goods as instances where “conspicuous expenditure” results in indirect economic advantage. Cail (2011) argues that dogs act as socioeconomic and political currencies spent on the feasting apparatus in which social relations between different households or neighboring villages are maintained. Thus, dogs are important for safeguarding alliances and reciprocal assistance in the long term. If Bridge River inhabitants valued the importance of these underlying prestige-based social constructs, it may very well explain why dogs continue to be prevalent throughout many generations in the HP 54 lifespan in which intense fluctuations of resource availability did not necessarily prevent the practice of dog ownership to come to a startling halt.

CHAPTER 4

HYPOTHESES, METHODS AND MATERIALS

This chapter presents the hypotheses, methods, and the materials that ground the entire project. There are three hypotheses (H1 thru H3): H1 (Hypothesis 1) suggests that, despite how costly dog upkeep can be, Bridge River inhabitants tactfully assigned canids various roles such that they can contribute to economic gain. H2 (Hypothesis 2) argues that it was advantageous to deploy dogs during hunts; they were heavily exploited during instances where it was necessary to hunt in greater distances to maintain caloric requirements. H3 (Hypothesis 3) assumes that dogs were only tactfully incorporated in the HP 54 diet during episodes of resource scarcity as a form of surplus food. The second section of the chapter examines the methods and materials, especially in regards to faunal dataset, the multivariate statistical approaches, and the logic of abundance indices.

This study's dataset is the result of multiple summer archaeological field seasons, spanning 2012 to 2014 and 10 floors (IIj-IIa) spanning between 20 or so years per floor. Data that will be discussed is not representative of the complete assemblage within a floor-by-floor basis; gaps in available data will be addressed. During excavation, the housepit units were divided into four 16 one meter by one meter Blocks (A, B,C, and D) with each Unit being subdivided into four 50cm x 50cm Quadrants (Quads). Multiple field seasons has produced substantial quantities of faunal remains with varying taxa, size, element type, and degrees of fragmentation. These initial findings have grounded the hypotheses and test expectations that will now be discussed in detail:

Hypotheses

The practice of dog ownership maximized potential caloric return and wealth acquisition at HP 54. Drawing from human behavioral ecology, I hypothesize that dog maintenance, in given conditions, was a highly adaptive strategy. Assigning dogs to specific tasks and roles allowed for HP 54 to be competitive with neighboring households. For example, as a food resource, they may have been tactfully incorporated in the household diet during episodes of low caloric availability.

Three hypotheses and their test expectations explore various ways to which dogs could have been exploited for securing household benefits. Test expectations were conceived while being consistent of both the strengths and limitations of the available archaeological data.

H1: Dogs as Signatures of Cost-Benefit Tactics

Being key players in household dynamics, canids can be susceptible to fluid caloric management on the household level. Archaeological evidence suggests that the HP 54 dogs continued to subsist while human population increased and local resource availability waxed and waned. This hypothesis argues that dogs provided benefits that outweighed upkeep costs because they can be assigned different roles and tasks dependent upon varying scenarios; when need be, they acted as hunting accessories, were deployed as a unit of storage, or were consumed as husbanded food. Dogs could have been, “beast[s] of burden for transporting other subsistence items in abundant quantity to feed the household and guests in wealthier pithouses” (Prentiss et al. 2014:44). Test expectations assume that the frequency of dogs in the HP 54 record change through time because inhabitants regulated pack sizes such that the practice of dog ownership

was calorically advantageous rather than costly. Dogs in the HP 54 archaeological record are expected to parallel caloric productivity in household economies. In principal components analysis (PCA) testing, the frequency of dog remains should correlate with frequencies of mammalian and salmonid remains bountiful as number of identified specimens (NISP).

H2: Hunting with Dogs to Increase Resource Utility

Dogs were valuable hunting accessories in Bridge River due to increased encounter rates and return rates of local fauna. The archaeological record in conjunction with HBE-influenced models validates the usefulness of dogs as hunters given the local environment's constraints; for example, "before hunters can identify the prey type and initiate pursuit, they must first catch up to the dogs, and their dogs sometimes chase unprofitable prey types" (Koster 2008:935). The caloric intake and encounter rate increases when hunting local fauna with dogs in contrast to hunting without dogs (Koster 2008). This hypothesis assumes that increased encounter rates would have been highly valuable during periods of resource scarcity when hunters would travel greater distances for the fauna they need; dogs would be useful in situations when game is far away. The general test expectation assumes that canid NISP would then be more prevalent in housepit strata containing higher frequencies of the meatier mammalian appendicular elements in contrast to axial elements. This hypothesis references the *direct* contribution of dogs in household economy; it is specifically concerned with how hunting dogs can directly increase household calories as measured by appendicular ungulate NISP.

H3: Mitigation of Caloric Stress

As evidenced by the ethnohistoric record, canid remains are oftentimes the product of human consumption. Foraging theory predicts subsistence decisions in relation to maximum forage return rates independent of long-term consequences (i.e. depletion) (Kaplan and Hill 1992). However, animal husbandry can also be regarded as *conservation*, a subsistence behavior “where the conserver checks his or her level of resource use to some point below what would be fitness maximizing in the short term” (Alvard and Kuznar 2001:295). This hypothesis assumes that the ultimate goal of dog ownership was the acquisition of long-term benefits (caloric) that sustained a household at either the minimal level or beyond, with the later contributing to village-wide inequality. If dog remains are more common on floors that endured resource scarcity, they were incorporated in the household diet as a last resort food item.

Archaeologically, canid remains would then retain a negative correlation between salmonid and mammal NISP; the logic being that HP 54 consumed dogs when the lack of availability in local salmonid and mammalian fauna was critically unsustainable. As fish and ungulate resources become more abundant, we should then expect to see fewer dog remains in the archaeological record and vice versa.

Methods and Materials

In-depth faunal analysis was possible via Dr. Anna M. Prentiss’ laboratory housed at the University of Montana in Missoula. Fauna were identified by students with the aid of the Philip L. Wright Zoological Museum and Montana Comparative Skeletal Collection to provide comparative samples; this allowed for faunal identification to the most specific taxonomic

classification. If taxon is indeterminate, then they were assigned to generic class sizes in relation to the animal type: small, small/medium, medium, medium/large, and large. The assemblage was calculated to Number of Identifiable Specimens (NISP); this is used to determine the ordinal-scale measurements of taxonomic abundance for each housepit floor. NISP allows us to then compare ratios of these abundances between floors, thus reflecting change of subsistence patterns through time (Grayson 1984; Reitz and Wing 2005).

NISP of the faunal assemblage will undergo principal components analysis (PCA). PCA is a statistical approach for determining underlying structures of complex data sets that are otherwise difficult to assess in a surface level. The analysis produces “components” that reflect underlying factors conditioning data structure. Also produced are factor scores which assess the degree to which different “components” are reflected within each floor. PCA is possible via the IBM SPSS Statistics 20 software. Ultimately, the goal is to determine whether dogs are important variables to consider in the HP 54 assemblage, possibly reflecting the general household economy as defined by faunal frequency.

Relative Abundance Indices of axial and appendicular ungulate elements will also be incorporated in the study. These measurements allow us to specifically test hypothesis number three, specifically in regards to whether evidence of field processioning coupled with lengthier travel distances correlate with housepit occupations who own more dogs; more dogs would raise resource utility in the field. These measurements have been proven to be useful in producing taxonomic values that are interpretable in zooarchaeological analyses (Broughton 1994a, 1994b). Produced indices allow for researchers to track changing frequencies of faunal resource. The initial uses of relative abundance indices in scholarly pursuits show how abundances of one taxon decreases as another taxon increases and vice versa (Bayham 1979). In the mid-1990s,

Jack Broughton (1994a, 1994b, 1995) and Joel Janetski (1997) suggest that indices are a staple analytical tool to assess subsistence fluctuations, and the intensification and depression of resources (Walsh 2015:151). Walsh (2015) successfully accessed temporal changes in prey acquisition at Housepit 54 by quantifying both relative taxonomic categories and identifiable taxa to relative abundant indices (Walsh 2015:152). He examined a floor-by-floor index that exclusively cross-compared frequencies of fish and artiodactyls. For this project, ratios of appendicular elements versus axial elements of medium sized fauna (size ranging from juvenile mule deer to as large as bears) will be calculated for each floor and compared:

$$\Sigma \text{Axial Elements} / \Sigma (\text{Axial} + \text{Appendicular Elements})$$

And

$$\Sigma \text{Appendicular Elements} / \Sigma (\text{Axial} + \text{Appendicular Elements})$$

Once the indices are produced, it will be cross-compared with floor-by-floor dog frequencies.

CHAPTER 5

ANALYSIS

The appearance of dogs within the HP 54 archaeological raises questions regarding their role within the village-wide context: Why they were owned, what roles they played, and to what degree were they valued and appreciated? Past hypothesis-driven research as well as the ethnohistoric record suggests that there is variability in canid “price tags.” On one end of the spectrum, they have the potential to drive wealth based status inequality (Cail 2011). On the flip side, they can exist solely for sanitation purposes. Fur traders’ accounts deem dogs as “unclean” animals; an interpretation is that, for certain contexts, dog upkeep was linked to human waste disposal (Cox 1957; Mack 2015). This chapter aims to piece together the statistical analyses derived from the IIj-IIa floors of the HP 54 site and aims to ask: To what degree do dogs contribute to Bridge River household economies?

This section is divided into three parts: an overview of the faunal assemblage, a principal components analysis (PCA), and an outline of relative abundance indices for artiodactyl axial and appendicular elements. An overview of the faunal assemblage will give context as to how different HP 54 floors exhibit differential faunal densities. Interpretations will be discussed regarding why these densities change through time in relation to demography and environmental conditions; these changes also coincide with changes in canid frequencies. The second section will incorporate multivariate analyses, specifically PCA. The goal here is to determine whether the canid variable is linked to other faunal variables and if so, assess whether these correlations are strong enough to consider canids as key players in household economy related to caloric-based wealth. The PCA portion aims to explicitly test hypothesis 1 and hypothesis 3. The results found that dog frequencies correlate positively with shifting floor-by-floor faunal NISP counts

because canid ownership is advantageous to both indirect and direct means of resource acquisition. Lastly, an exploration of relative abundance indices on artiodactyl appendicular and axial elements will attempt to tackle the second hypothesis: dogs would be used in hunts more often during periods of resource scarcity since they increase both encounter and return rates, favorable traits during times of high risk. Floor-by-floor ratios of appendicular and axial elements will be compared with floor-by-floor canid frequencies.

Faunal density trends at HP 54 are generally complex. At surface level interpretation, HP 54 diet primarily consists of terrestrial fauna and fish, keeping in mind that geophytes, berries, and additional wild plant foods are most presumably a large part of inhabitants' diet as well (Walsh 2015). On closer inspection, variability in the frequencies of terrestrial fauna and fish showcase complex relationships throughout multiple generations. The specifics on how subsistence trends change through time will be further explored when data is analyzed and interpreted throughout the project. The total faunal assemblage is showcased in Table A.1. Worth noting is how the general canid sample size is relatively small. Despite these size constraints, incorporating dogs in the study is still worthwhile because this analysis explicitly analyzes the underlying patterns related to dog maintenance: To what degree does the appearance of dogs in the archaeological record reflect the changing frequencies of other fauna?

When incorporated into multivariate analyses, faunal frequency (in regards to NISP) is a valuable asset for answering an array of questions. The following section provides a look into underlying associations between variation in dogs and the frequencies of other fauna organized by species. Specifically, the principal component analysis (PCA) will allow for the examination of underlying structures within complex data sets. Fauna is an important archaeological variable to assess and explore because they represent the variation in food resource acquisition in a

Bridge River context. Interpreting what resources gets acquired allows us to not only understand what HP 54 people consumed, but can also question whether or not certain households had limited access to critical subsistence resources.

One assumption made is that frequencies of identifiable dogs in particular strata (house floor) represent the entire dog population in which HP 54 owned during a particular time; this is most likely not the case since there was probably variability in the treatment of deceased canids. It is worth reminding that dog remains are also found in other housepits within the Bridge River village. Despite this assumption, PCA in a later section of this chapter will allow for a statistical exercise to explore how fluctuating variables affect one another. Before PCA results are extrapolated, it is best to situate the study with an overview of dog frequencies and how they shift throughout IIj-IIa.

Faunal Density Trends

In order to gauge how dogs are incorporated in the schematics of subsistence change through time, it is best to put canids in context alongside the cumulative mammal and fish record. In general, relative contributions of fish and mammal in the HP 54 diet fluctuate through time as evidenced by Walsh's (2015) calculation of general Mammal/Fish Index. Since NISP was derived from the record, it is worth noting that higher frequencies can indicate greater degrees of fragmentation thus raising overall count. Thus, to mitigate sample size discrepancies, multivariate analyses use bones that were identified to genus and element type; a separate analysis incorporates indeterminate remains. Another form of sample size bias can be linked to presently available data: to date, IIj-IIh in situ samples come exclusively from Block A, thus

accounting to about 50% of IIg-IIf findings on a per-floor basis. In order extrapolate absolute frequencies, densities of mammal and fish remains were calculated by dividing the number of mammalian and fish specimens by the total volume of sediment excavated per stratum (Walsh 2015:171). These calculations are presented in Table 5.1 and Figure 5.1.

Table 5.1. Excavated Faunal Remain Densities by Excavated Volume by Stratum

Stratum	Excavated Volume (m ³)	Salmon Density	Terrestrial Mammal Density
IIj	0.161	441	521.7
IIi	0.297	382.83	252.53
IIh	0.374	357.3	320
IIg	0.6	248.3	625
IIf	0.7207	677.11	752.04
IIe	0.7341	370.52	416.83
IIId	0.8	293.75	347.5
IIc	1.004	476.09	601.59
IIb	0.908	2084.33	969.56
IIa	1.65	966.069	1243.32

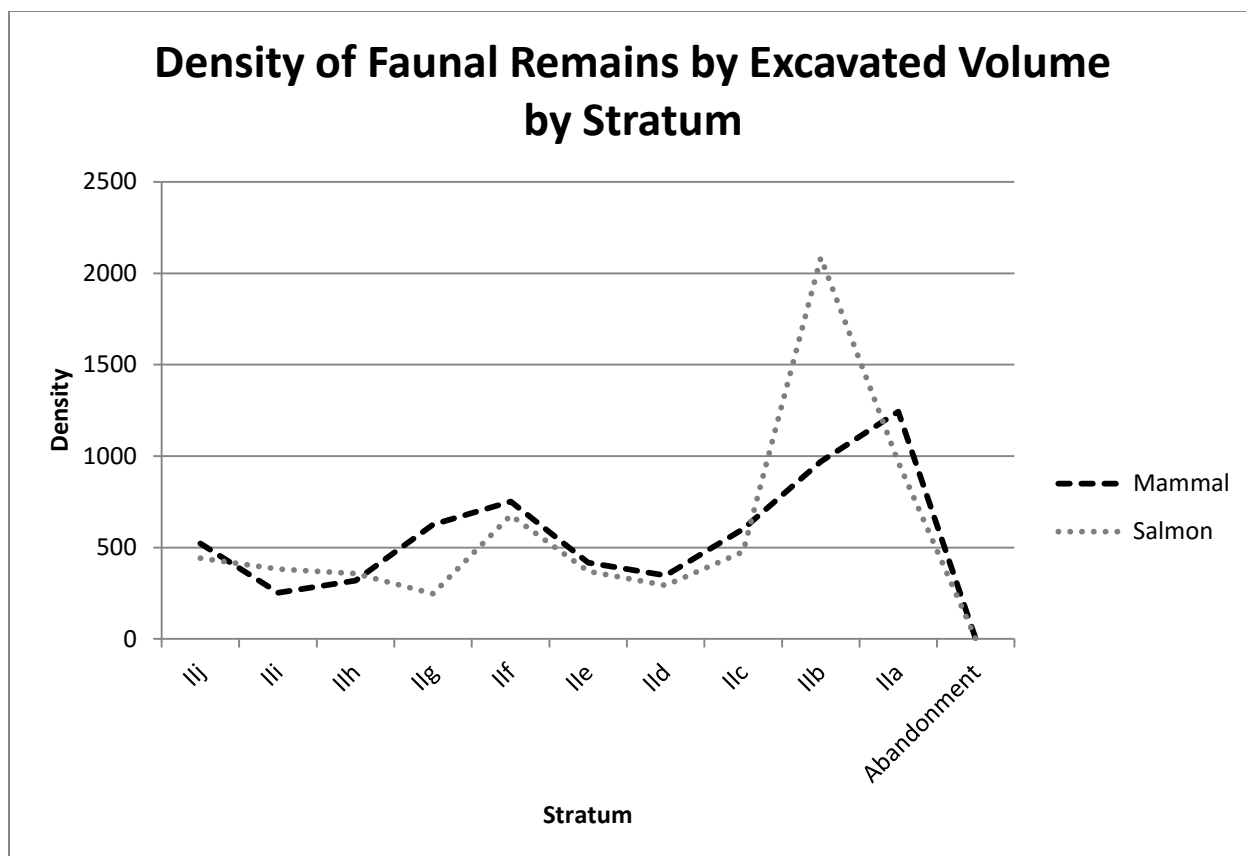


Figure 5.1. Excavated Faunal Remain Densities by Excavated Volume by Stratum.

General subsistence trends will now be discussed via density data (Table 5.1 and Figure 5.1) alongside NISP trends (Table A.1): IIj utilized fish and mammals in equal proportions as evidenced by Block A. As this is the initial occupation stage for the available archaeological dataset, dogs begin making an appearance from the earliest excavated floor at HP 54. In IIi, dogs disappear from the record and fish become more prominent in the diet ever so slightly and as the IIh period approaches, the diet retracts to equilibrium. IIh also marks an immediate spike in the dog population ($n=7$). It is worth noting that since IIi and IIh only represent Block A, more canids may have been present during this period; this is especially likely given that dog frequencies are generally low in the first place. While only one dog remains was recorded in IIg,

mammalian fauna in this period becomes more prominent in the record compared to fish. During II_f, the canid population rebounds to $n=7$ as the general dietary ratio once again reaches equilibrium; mammal numbers increase alongside a dramatic increase in fish. Walsh (2015:163) argues that this event coincides with a growing household size where more food being brought in was required to sustain the population. As II_e approaches, all animal densities dip while dog NISP dramatically falls from 7 to 1; this marks the beginnings of the BR2-BR3 transition where all faunal remains in the household drop, possibly signaling population decline during the II_e-II_c range. II_c initiates a trend where both the mammal and fish densities increase overall, with mammals exhibiting a slight edge. Dogs from hereon in begin to retain a fairly consistent population that neither increases nor decreases in dramatic spikes. Fish NISP spikes by 400% in II_b, an indicator of high population densities in HP 54, further evidenced by general fragmentation of mammal bone which correlates with higher degrees of bone processing (Table A.1). II_a, the precursor to abandonment, showcases a peculiar trend where a fish-specialized subsistence strategy could have been an attempt to support overall population growth; once this strategy failed, a last resort reliance on mammals, as evidenced by increased bone fragmentation again, was not enough to sustain the high density, leading to abandonment (Walsh 2015). Another interpretation for dramatic fish increases may be linked to high numbers of fish conveniently collected fish during a period of substantial population growth during a short span of time (Prentiss, personal communication 2016). Dogs still co-exists with their HP 54 brethren up to abandonment.

There are two distinct canid NISP frequency trends: the population post BR2-BR3 transition and the population during and before the BR2-BR3 transition. Floors II_j through II_e retain dramatic shifts in NISP, fluctuating back and forth between 1 or 0 and 7 for multiple

instances. It is from IId onwards, post the BR2-BR3 shift, where it is noticeable how dog NISP is stable, either increasing or decreasing by 1. Canid NISP size stabilization also occurs amidst stable subsistence-strategy practice, as indicated by stable mammal to fish ratios showcased in IIf through IIc.

Initial dramatic fluctuations in canid frequency may be indicative of consumption. The Death Curve established by Cail (2011) examines the percentage of deaths at any given age interval. It is suggested that the risk for death is greatest between the ages of 8 months to 2.5 years. Once dogs last over the age of 2, they are more likely to survive up to 8+ years (Cail 2011:85). Since each floor is representative on approximately 20 years, the waxing and waning of canid population may be the result of managed life cycles. However, since the available canid sample size is small, it is difficult to assume validity for these types of speculations at HP 54.

Dogs remained present from IId onwards. Whether dogs continued to be consumed or not, higher frequency of dogs seem to be present during a period where village-wide inequality reached its peaked. BR3 was when communal feasting events would have commonly taken place as evidenced by surrounding ovens (Prentiss et al. 2012). BR3 could have been the period in which prestigious households began to take claim on highly productive fishing rocks prominent throughout the western shores of the Six-Mile Rapids (Walsh 2015:196). If this is the case, dogs maintained during BR3 may have acted as a prestige item within a prestige economy. Ames et al.'s (2015) stable isotope analysis deems dog maintenance as a considerably costly endeavor. Alongside the spike in population density in IIb, fish could have been acquired in high bulk to accommodate such high household caloric intake. Dogs could then continue to subsist on fish, even in IIa where fish populations may have undergone significant drop, resulting in household “last-minute” reliance on mammalian fauna.

Principal Components Analysis

Four separate PCA analyses were conducted. The first test examines all of the fauna at broad taxa categorizations, not going beyond order with the exception of the canidae family. Next, this section will incorporate dogs (under the canidae family) alongside other types of fauna: 1) Dogs and fish; 2) dogs and mammalian fauna; 3) dogs and indeterminate mammalian elements of varying sizes. By initiating independent PCA tests, it is possible to further hone in underlying co-associations. Based upon the initial PCA that incorporates all fauna, I was able to identify strong signals. The other three PCA analyses hones in on underlying association between dogs and specific types of taxa.

Table 5.2. Initial statistics and component matrix for PCA of all fauna

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.272	65.442	65.442	3.272	65.442	65.442
2	.904	18.077	83.519			
3	.535	10.706	94.225			
4	.259	5.178	99.403			
5	.030	.597	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix ^a	
	Component
	1
Mammalia	.905
Osteichthytes	.903
Canid	.699
Artiodactyla	.961
Rodentia	.475

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

An initial PCA of the cumulative faunal frequency yielded results suggesting that dogs exhibit very strong co-associations with other fauna in the HP 54 complex (Table 5.2). With an eigenvalue score of 3.272 and only a single derived component score, this initial test implies that dogs in the archaeological record are reflective of the NISP of all fauna (.90 average component value for component 1). This component correlates most strongly with determinate mammalian, artiodactyla, osteichthytes, and rodentia elements. The general interpretation suggests that shifting frequencies of all fauna ultimately reflect archaeological representation of other fauna. Dogs retain a loading of .699, revealing that, at the broadest scale, canid frequency at HP 54 generally increase as the frequencies of fish and mammals increase and vice versa.

Table 5.3. Component scores for PCA of all fauna. Bolded scores are at 1.0+ in either positive or negative dimension.

<i>Floor</i>	<i>Component Scores</i>
Ila	1.65600
Ilb	1.64951
Ilc	0.09916
Ild	-0.41297
Ile	-0.16738
Ilf	0.48879
Ilg	-0.60597
Ilh	-0.47077
Ili	-1.11772
Ilj	-1.11864

Dogs and Fish

Similar to the all-encompassing PCA test, the PCA of dogs and salmonid taxa yielded only a single component score alongside an eigenvalue of 3.539. Dogs retain a strong component value of .735 alongside very high values for trout-sized c.f. *Salmonid* (.975) c.f. *Oncorhynchus nerka* (.975), and general *Salmonidae* (.887) (Table 5.4). Chinook salmon (*O. tshawytscha*) retained the lowest component score out of all of the variables (.556), although the score is still moderately strong. Given that the canid diet at HP 54 appears to be composed solely of salmon (Diaz 2015), the high component values are not all too surprising. Chinook salmon is the least represented fish in the archaeological record. Worth noting are the 377 indeterminate fish elements that may skew the overall results (Table A.1).

Table 5.4. Initial statistics and component matrix for PCA of dogs and fish.

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.539	70.786	70.786	3.539	70.786	70.786
2	.807	16.146	86.932			
3	.554	11.081	98.013			
4	.056	1.121	99.134			
5	.043	.866	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix ^a	
	Component
	1
Canid	.735
Salmonidae	.887
c.f. <i>Oncorhynchus nerka</i>	.975
c.f. <i>Oncorhynchus tshawytscha</i>	.556
c.f. <i>Salmonid</i> (trout-sized)	.975

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Table 5.5. Component scores for PCA of dogs and fish. Bolded scores are at 1.0+ in either positive or negative dimension.

<i>Floor</i>	<i>Component Scores</i>
IIa	1.37316
IIb	2.12497
IIc	-0.10091
IId	-0.37782
IIe	-0.64358
IIf	0.28059
IIg	-0.7898
IIh	-0.31756
IIi	-0.89425
IIj	-0.65481

Strong stable carbon and nitrogen isotope signals of dogs with sockeye salmon (*Oncorhynchus nerka*) and other salmon species indicate the required household currency for dog upkeep. Despite being surrounded by a diverse subsistence base that grounds the Bridge River diet, dogs are special in that they subsist solely on marine-based protein. Stable isotope analysis on dog remains from Cathlapotle (Ames et al. 2015) and Bridge River (Diaz 2015) confirms significantly narrow diets for dogs. The mean $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values associated with *C. familiaris* is $-15.8 \pm .2\text{‰}$ and $13.6 \pm .15\text{‰}$, demonstrate close levels of clustering around sockeye salmon and salmonid $\delta^{13}\text{C}$ range of $-16.08 \pm .8\text{‰}$ and $-16.11 \pm .4\text{‰}$ respectively as well as the

mean sockeye salmon versus salmonid: $\delta^{13}\text{C}$ of $10.62 \pm 1.2\text{‰}$ versus $10.37 \pm .6\text{‰}$ respectively (Figure 5.2). Overall, canids belonging to HP 54 were exposed a rich and diverse array of harvest resources from both the aquatic and terrestrial habitats similar to Cathlapotle, but were not foraging on a full spectrum of available options that were hauled back to the village (Ames et al. 2015:279). The Cathlapotle and the Bridge River HP 54 findings are supported by both archaeological and ethnographic records suggesting dogs' salmon diet (Crellin 1994; Crellin and Heffner 2000; Hayden and Schulting 1997). Ames et al. (2015) speculates that dogs were most likely tied or penned, thus allowing for selective feeding.

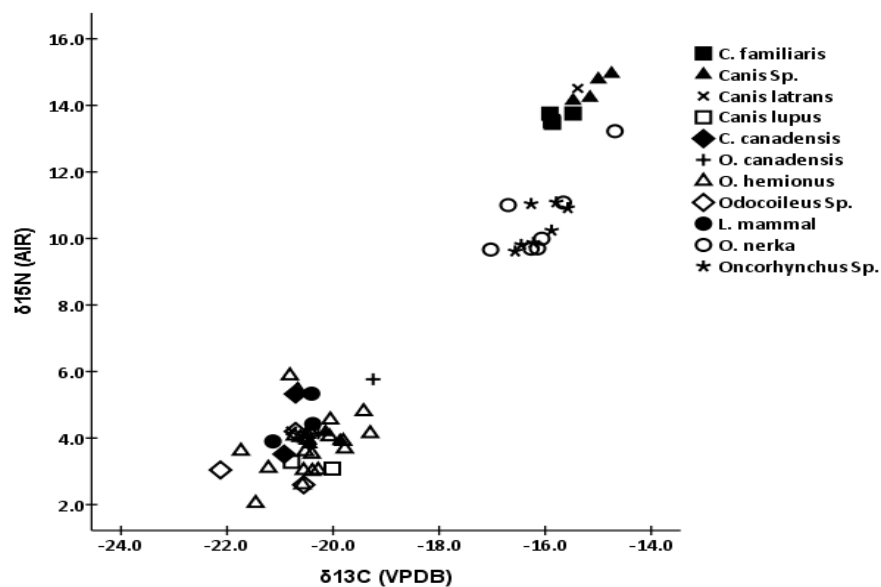


Figure 5.2. Stable Isotope Analysis of Dog Remains at Housepit 54, Bridge River

The stable isotope data alongside strong PCA signals assumes that the upkeep of dogs is determined by access to sockeye salmon (*O. nerka*). Interestingly, if we examine general trends in canid frequency at HP 54, the period immediately following the BR2 to BR3 transition (floors IIe and IId) have relatively small dog NISP compared to all strata combined: 1 dog identified on

Ile and 4 identified on IId (Table A.1). The post-BR2 and BR3 transition also marks the move towards greater access to resources considered to be high-ranked (high utility). Chinook salmon, in particular, have been identified as potential “prestige foods” on the basis that they good tasting and are more difficult to acquire due to swimming in deeper channels and low catch rate via traditional dip-nets (Walsh 2015:196). On a caloric standpoint, chinook is particularly fatty (Kew 1992). As a food resource that is significantly linked to village-wide socioeconomic disparities, it must be noted that dogs are also linked within this general network.

Dogs and Identifiable Mammalian Fauna

Three component scores were derived from the PCA analysis. A rotated component matrix was made possible via Varimax with Kaiser Normalization to extract underlying variability that was not possible with a single PCA extraction. Interestingly, dogs, mule deer, and beaver have the highest loadings with .924, .716, and .778 respectively (Table 5.6). These strong scores coincide with weak co-associations with *Ovis Canadensis* (bighorn sheep) (.180) and inverse association with *Ondatra zibethicaus* (muskrat) and *Peromyscus spp* (deer mice). The second component does not incorporate dogs by exhibiting a -.170 loading but instead focuses on non-cultural factors, especially since deer mice exhibit high loadings; mice are probably just household pests that are not explicitly sought after by village inhabitants. The deer loading coinciding with the deer mice loading in component two is probably fortuitous.

These results showcase the significance of dogs in the archaeological record as a worthy predictor of mammalian frequency. The first component (eigenvalue score of 2.018) is ultimately a reflection of dogs in conjunction with beavers and medium to large sized fauna. Canid

frequencies are generally larger when there is higher representation of fauna within this particular spectrum.

Table 5.6. Initial statistics and component matrix for PCA of dogs and identifiable mammals.

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.232	37.207	37.207	2.232	37.207	37.207	2.018	33.630	33.630
2	1.549	25.809	63.016	1.549	25.809	63.016	1.608	26.805	60.435
3	1.131	18.845	81.861	1.131	18.845	81.861	1.286	21.427	81.861
4	.698	11.632	93.494						
5	.240	3.999	97.492						
6	.150	2.508	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix ^a			
	Component		
	1	2	3
Canid	.924	-.170	-.192
Odocoileus hemionus	.716	.583	.228
Ovis canadensis	.180	-.713	.457
Castor canadensis	.778	-.285	.371
Ondatra zibethicaus	-.036	-.062	-.907
Peromyscus spp.	-.111	.803	.165

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Table 5.7. Component scores for PCA of dogs and identifiable mammals. Bolded scores are at 1.0+ in either positive or negative dimension.

<i>Floor</i>	1	2	3
Ila	0.69555	-1.92913	1.12884
Ilb	1.75870	1.83145	0.29864
Ilc	0.17855	-0.24727	-0.05017
Ild	-0.10219	-0.17621	-2.58271
Ile	-0.76505	0.80096	0.72396
Ilf	0.95045	-0.16459	-0.11778
Ilg	-0.55013	-0.03706	0.31940
Ilh	0.43013	-0.61069	-0.16019
Ili	-1.43010	0.83518	0.53714
Ilj	-1.16592	-0.30264	-0.09711

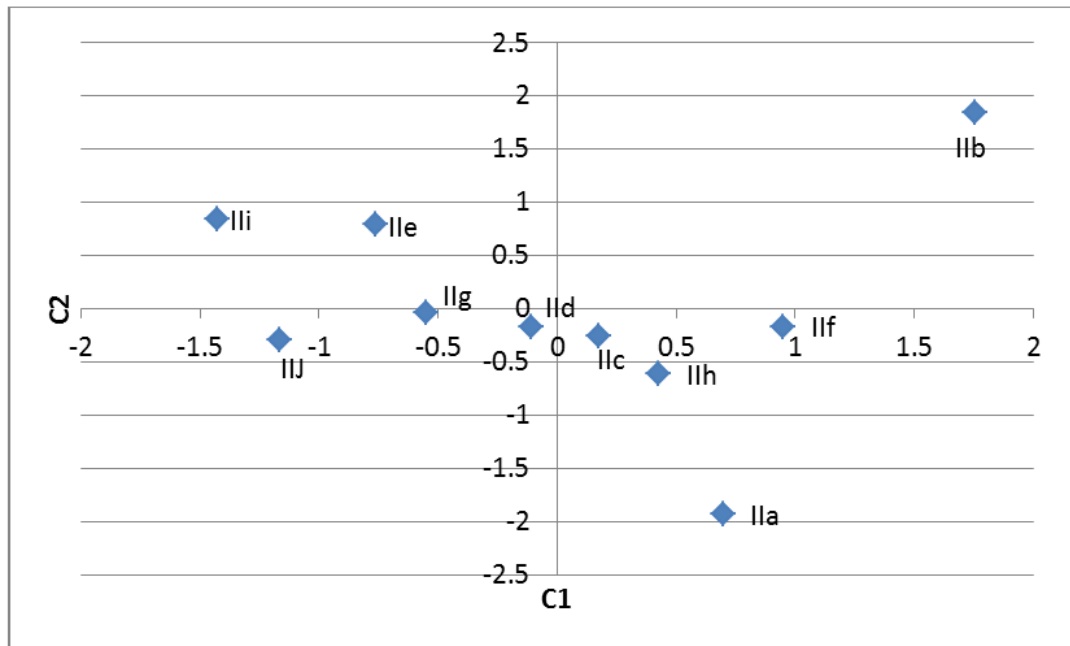


Figure 5.3. Plot of dogs and identifiable mammals component scores with component 1 on the X axis and component 2 on the Y axis.

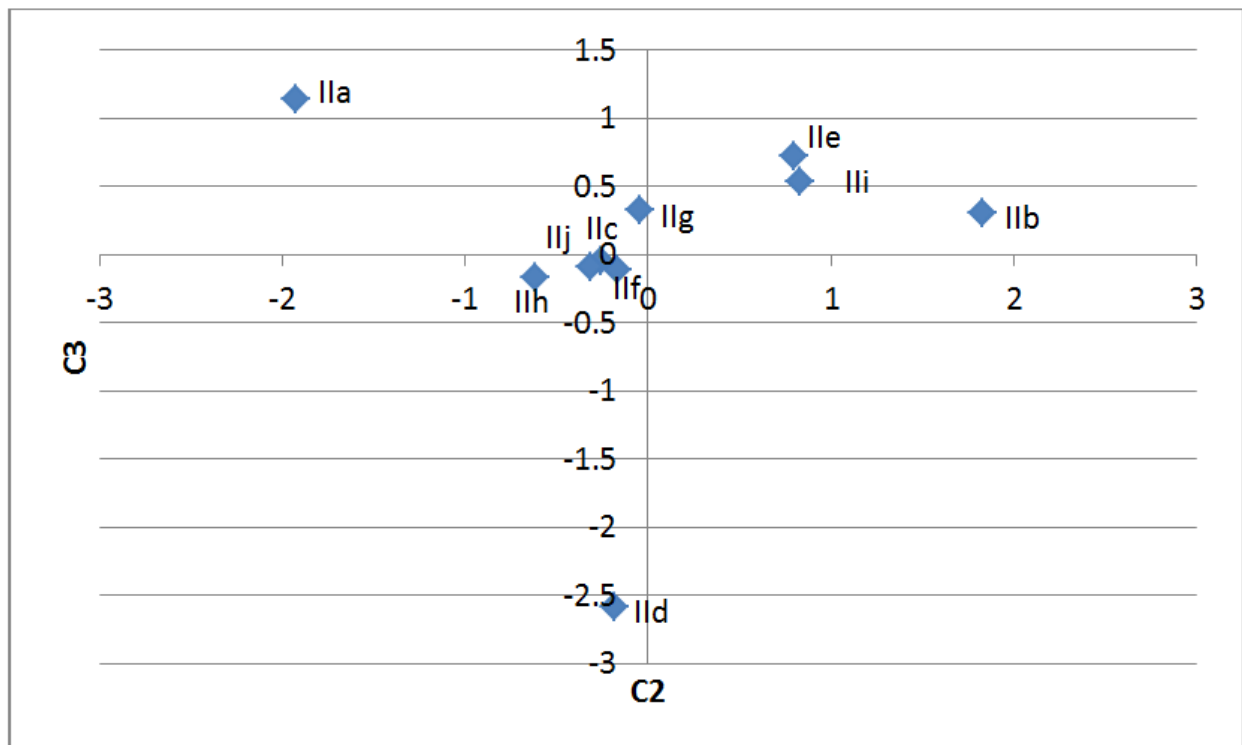


Figure 5.4. Plot of dogs and identifiable mammals component scores with component 2 on the X axis and component 3 on the Y axis.

Strong component scores are representative in floors IIb, IIf, Ili, and IIj. This creates dichotomous pairings of extremes: IIb and IIf represent the highest population of dogs whereas Ili and IIj represent periods in which dog frequencies were at its lowest. As these floors represent periods in which dogs express strong positive and negative co-associations with terrestrial fauna, the component scores measure the degree to which each floor contributes to each component. Since dogs are highly representative of the first component, component 1 will be the focus of this particular analysis. Ili and IIj are floors where an episodic increase of NISP in overall mammals coincided with a decrease in dogs. In other words, there were fewer dogs when there were less mammals as HP 54 inhabitants began to decrease hunting and fishing activities from a previous generation or two. In contrast, strong positive factor scores associated with floors IIb and IIf had a large number of dogs that coincided with both a spike in mammalian and fish remains.

Dogs are indicators of mammalian-related subsistence-based wealth predominately in dramatic instances where resource acquisition tactics change or environmental conditions shifts. Dogs were not prominent in earlier floors, yielding little effect on household economy because this is due to sample size bias or they were either 1) too costly for upkeep given the current demographics and available resources; 2) conditions prevented dogs from being deployed in hunts such that they increase hunting efficiency. These initial floors represented a time in which population was slim and the waxing and waning of mammals were relatively minuscule compared to the IIc-IIa floors. If the upkeep of canids would have been a costly endeavor in Ili and IIf (episodic spikes in mammalian NISP), the assumption is that dogs were not deployed as hunting aids or, if they were, only one or a couple were utilized. In IIb, dogs could have been more useful in hunting roles, acted as signalers of prestige, and played a more dynamic role in a demographic peak, especially since household demography gradual increased through time (Walsh 2015:178).

Dogs and Indeterminate Mammalian Fauna

Two component scores were derived from the PCA analysis (Table 5.8). The first component (eigenvalue score is 2.121) in the rotated component matrix incorporates dogs, with the highest loading at .838, alongside a strong co-association with medium-sized mammals (.756) and moderate association with large mammals (.540). The second component (eigenvalue score is 1.805) measures varying degrees of association with all indeterminate fauna with dogs, suggesting that the frequencies of dogs is reflective of varying frequencies of mammals as a whole (Table 6.7).

Table 5.8. Initial statistics and component matrix for PCA of dogs and indeterminate mammals.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.632	43.869	43.869	2.632	43.869	43.869	2.121	35.346	35.346
2	1.294	21.568	65.437	1.294	21.568	65.437	1.805	30.091	65.437
3	.991	16.515	81.952						
4	.740	12.331	94.283						
5	.276	4.599	98.882						
6	.067	1.118	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix^a

	Component	
	1	2
Canid	.838	.266
mammalia sm	.049	.700
mammalia - sm/med	-.734	.359
mammalia - med	.756	.336
mammalia - med/lrg	.125	.836
mammalia - lrg	.540	.552

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 5.9. Component scores for PCA of dogs and indeterminate mammals. Bolded scores are at 1.0+ in either positive or negative dimension.

<i>Floor</i>	<i>1</i>	<i>2</i>
Ila	-0.22524	1.90473
Ilb	0.55114	1.26102
Ilc	1.12258	0.03941
Ild	0.80799	-0.14159
Ile	-0.42122	0.23189
Ilf	1.08643	-0.29137
Ilg	-1.49278	-0.04576
Ilh	0.48815	-1.34733
Ili	-1.69013	-0.30226
Ilj	-0.22691	-1.30874

Factor scores with strong positive correlations for component 1 exist in floors Ilc and Ilf and floors Ila and Ilb for component 2 (Table 5.8). Although factor scores suggest that dogs had a negative relationship with certain types of mammalian fauna in Ila, there are some minimal to moderate degrees of association in component 1 related to floor Ilb. Interestingly, the Ila factor score from the PCA of dogs and identifiable mammalian fauna exhibits a similar trend where the impact of dogs on the household economy is positively stronger in Ilb than it is in Ila (in which, this case, has a completely negative association as exemplified in the factor scores on Table 6.8). One interpretation is that dogs had the most economic impact in Ilb because it was at the height of population growth and mammalian acquisition. Ila becomes a more critical time in which

resources were becoming noticeable more scarce and inhabitants might have been reluctant to expend high caloric upkeep costs on dogs.

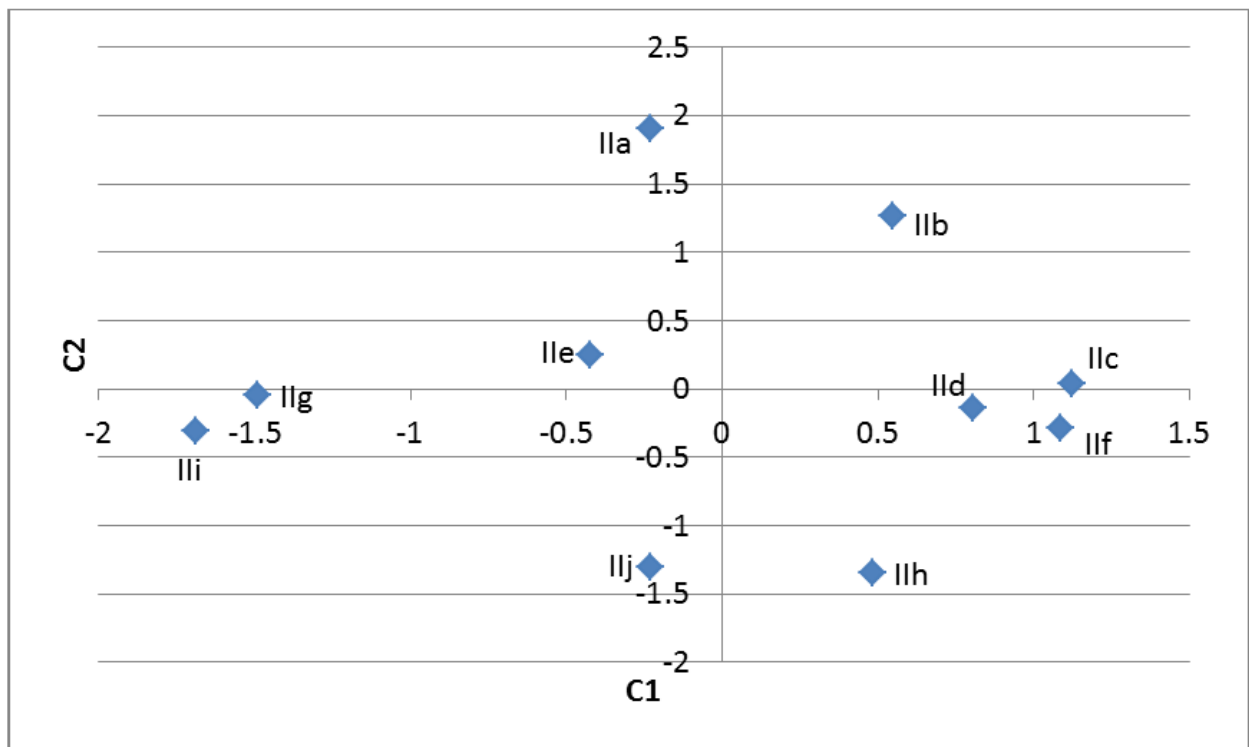


Figure 5.5. Plot of dogs and identifiable mammals component scores with component 1 on the X axis and component 2 on the Y axis.

Relative Abundance Indices

In order to explore H2 (Hypothesis 2), this project utilizes relative abundance indices on medium sized to large sized mammalian fauna, examining the different proportions of axial and appendicular elements per stratum; the size range for the analysis incorporates animals as small as juvenile mule deer and as large as bears while excluding rodent-sized fauna. The logic is that dogs were deployed during hunts to: 1) increase calories returned per dog compared to when dogs are not utilized; 2) save kilocalories by nixing the need for human individuals to exert their own calories to haul the same weight back to the base camp (Koster 2008; Shimek 2014). If dogs

were successful at providing such benefits, their incorporation in hunts could be particularly imperative in instances where resources are scarce; any tactics that would increase resource utility should have been exploited. Rodent-sized fauna that could have been captured by dogs would most likely not have to undergo rigorous butchering practices since they were mostly likely hauled back to camp as full carcasses. Overall, the assumption for H2 is that hunting canids were high commodities in village-wide complex during times of resource scarcity.

Bridge River inhabitants incorporated different techniques and strategies that would sustain a household in given situations. For example, the acquisition of larger prey (i.e. bears) would hypothetically involve small hunting bands. In other instances, solo hunts may be more appropriate, especially if there was an abundance of local medium-sized mule deer thriving in the general vicinity (Teit 1906:237, Kennedy and Bouchard 1978). As discussed earlier, “Central Place Foraging Models” are applicable to this study because they explore fitness-related decision making processes in the archaeological record; it is possible to interpret how tangible evidence involving animal transport and in-field versus base camp processing reflects a cost-benefit mindset in given scenarios. The “General Field Processing Model” (Metcalf and Barlow 1992) stems from Central Place Foraging, and determines the optimal choice in resource package acquisition. For example, determining whether it is more cost effective to transport an entire deer carcass or to instead do field processing and return to camp with the meatiest bits.

Following the logic of the “General Field Processing Model,” relative abundance indices acknowledge appendicular and axial ratios as key indicators of hunter decision making regarding variability in butchery practices. In the broadest sense, the model determines whether it is more optimal to either allocate time and energy to process the hunted animal or, in contrast, to expend more time and energy to transport the entire animal (or larger parts). The appendicular skeleton

is composed of limb-related elements such as the scapula, femur, tibia, radius, humerus, and ulna. In contrast, the axial skeleton comprises itself of vertebral elements, cranial elements, and ribs. White (1952) argues that assemblages with higher proportions of limb elements rather than appendicular elements are oftentimes reflective of selective transport strategies; in other words, in-field processing prioritized over hauling an entire carcass back to home base. The assumption is that “the effort spent in disarticulating smaller prey may be more efficiently done back at camp because the transportation costs associated with even a whole but smaller/lighter carcass are significantly less than those of transporting a whole larger one (paraphrased from Walsh 2015:110).” Under the logic of the *Schlepp Effect*, a term coined by Perkins and Daly (1968), axial elements should logistically be the first sections abandoned if it is necessary to leave something behind. For example, meat-marrow rich upper limbs are preferable over the vertebral column because of differences in potential kcal dependent upon bulk (Walsh 2015:110).

Table 5.10. Axial relative abundance index and canid NISP (Missing Floors Ili-h and IIf)

Strata	Canid NISP	Axial and Appendicular NISP	Axial NISP	Axial Index
Ila	6	98	60	0.612244898
Ilb	8	234	54	0.230769231
Ilc	6	52	41	0.788461538
Ild	5	27	19	0.703703704
Ile	1	35	13	0.371428571
Ilg	1	59	42	0.711864407

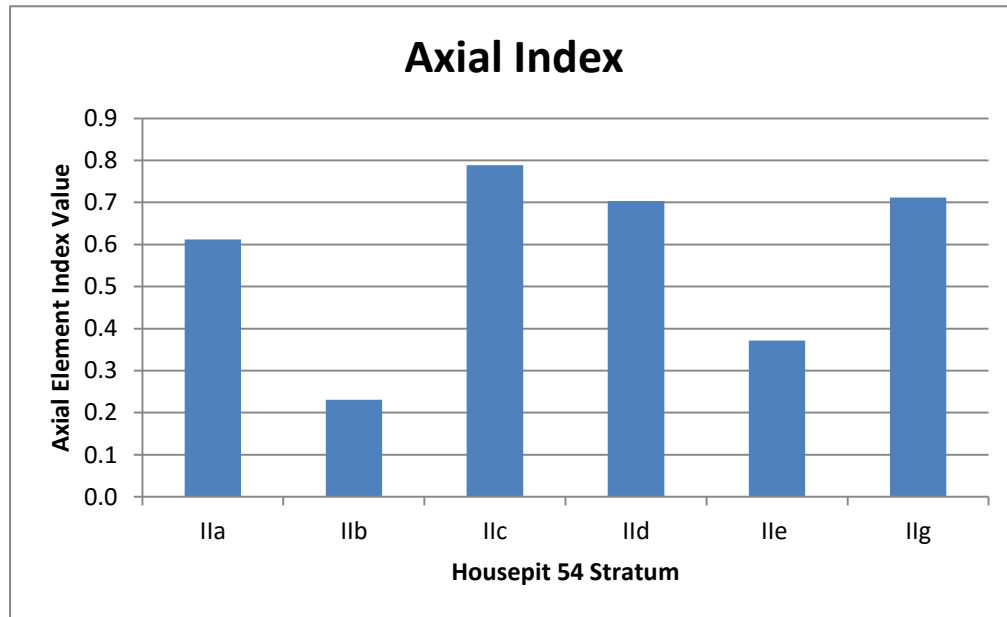


Figure 5.6. Axial Relative Abundance Index (Missing Floors I Ii-h and I If)

The results suggest that there is a relatively high proportion of medium to large-sized mammalian NISP identified as axial parts with the exception of floors I Ie and I Ib where there is a significant shift to appendicular elements (Table 5.10; Figure 5.6). This analysis was unable to incorporate floors I Ii-IIIh and I If due to missing data. Floors I Ia, I Ic, I Id, and I Ig average about a 70% representation of axial elements, making axial elements disproportionately available, thus implying that a large quantity medium and large sized terrestrial fauna were readily available near the village during the majority of habitation periods. However, this initial interpretation of the indices does not dictate the complexity of fluctuating resources within the general environment.

Table 5.11. Appendicular relative abundance index and canid NISP (Missing Floors Ili-h and IIf)

Strata	Canid NISP	Axial and Appendicular NISP	Appendicular NISP	Appendicular Index
Ila	6	98	38	0.387755102
Ilb	8	234	180	0.769230769
Ilc	6	52	11	0.211538462
Ild	5	27	8	0.296296296
Ile	1	35	22	0.628571429
Ilg	1	59	17	0.288135593

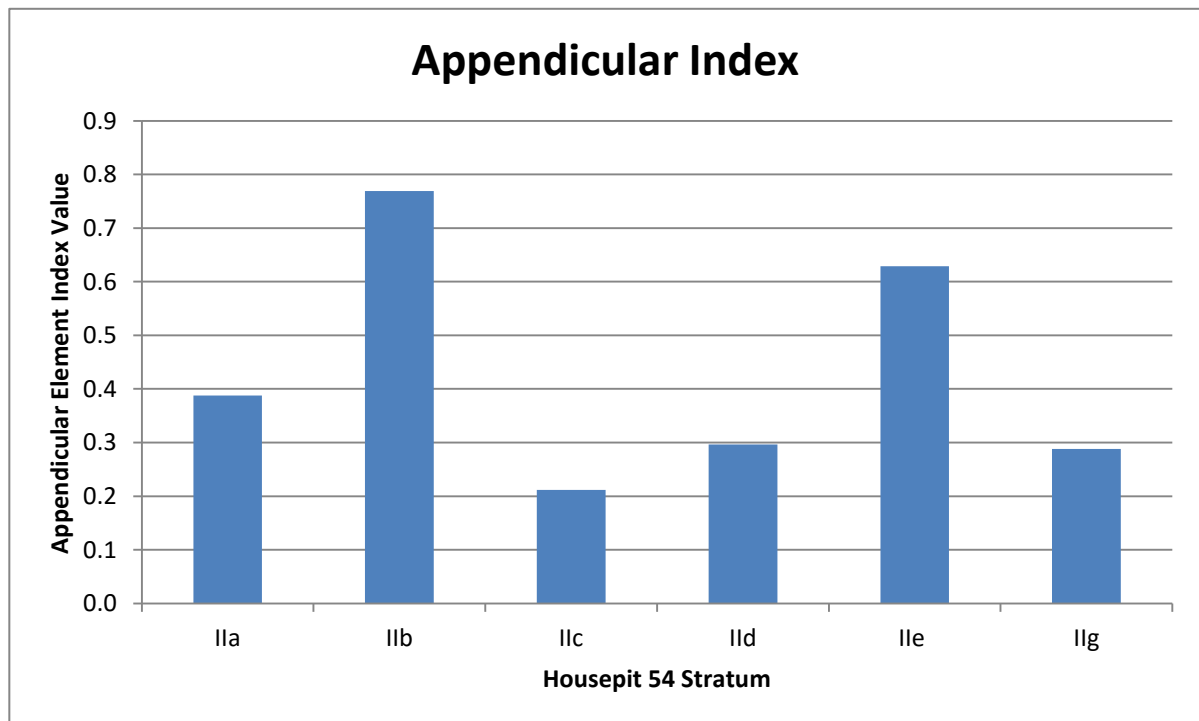


Figure 5.7. Appendicular Relative Abundance Index

Although there are still higher proportions of axial compared to appendicular in the IIg floor, Walsh (2015) mentions that the shift from IIh (not incorporated in this analysis) to IIg exhibits a noticeable increase of artiodactyl-based appendicular elements, particularly specimens consisting of entire forelimbs. This trend extends into stratum IIe, which is clearly well-defined in this study's appendicular index of .628, marking the transition from BR2 to BR3. Although a relatively high axial index value is presented for IId, Walsh (2015) notes that the floor is predominately composed of limb elements; an explanation for this discrepancy is the fact that only identifiable artiodactyls were incorporated in the study. In contrast, the relative abundance analyses incorporated all mammals where element type could be identified, but not the order or genus. Only 6 identifiable artiodactyls with axial association were derived from the dataset. Five cranial elements of indeterminate mammals and 3 lophodont elements of known artiodactyls may skew such results. It is worth noting that IId is the floor where there are significantly low numbers of identifiable artiodactyls overall; in fact, it is the stratum where identifiable artiodactyl remains reaches low frequencies across the overall assemblage alongside limited mass-acquisition of anadromous salmon indicating considerable population decline (Prentiss et al. 2014). Despite this influx, salmon was a subsistence base important throughout the entire village lifespan. One alternate explanation for higher axial versus appendicular ratio during this episode of resource depletion/stress (IId) is the acquisition of deer in closer proximity; since the shift towards salmon procurement became more fundamental, perhaps HP 54 inhabitants treated ungulates as a secondary resource, taking advantage of hunting terrestrial faunal when convenient, but not necessarily worrying too much about field butchering practices that aim to achieve highest degree of caloric potential. Another interpretation could be that, due to lower population, the artiodactyl resource is not as pressured compared to later floors. As such, deer

were able to thrive in greater numbers and were more accessible in closer proximity to the Bridger River village, hence the higher axial versus appendicular ratio.

The final outcome of the PCA results suggests that dogs had the highest degree of economic impact in IIb. Deciphering how dogs impacted resource-based household economy requires that some degree of speculation be made: what exactly is the role of dogs during acquisition boom in conjunction with population rise? The relative abundance indices exhibit highest appendicular to axial element ratios in IIb. Although missing data (floors Iii-IIh and IIf) and taphonomy may have skewed overall ratios when examining all ratios for all floors, IIb results match well with PCA results: Based upon PCA loadings and factor scores, IIb should be the floor most representative of a scenario where high dog frequencies correlate with high frequency of mammals. Emphasis on limb-related elements during IIb suggests that mammals were acquired in far distances. Thus, if dogs were strategically deployed as hunting aids in instances where high travel distance was required, it would have happened effectively in IIb.

CHAPTER 6

DISCUSSION

This case-study on Bridge River's Housepit 54 provides an in-depth analysis on dog-use in the context of complex hunter-gatherer-fisher villages of the Canadian Plateau. This particular pithouse was particularly active and occupied for 200 years, circa 1350 cal. B.P. to 1150 cal. B.P. Distinct periods of approximately 20-25 years of perennial occupation are preserved via stratigraphic floors layers. Whenever a new floor was initiated, the ash record would preserve the remains of dogs alongside other fauna, stone tools, and storage and cooking features are preserved. Archaeological findings suggest that pithouse inhabitants owned dogs with fluctuating pack sizes through time. Dog ownership is a costly endeavor, requiring constant supply of caloric currency for maintenance. Due to prolonged traditions, dogs at HP 54 were selectively fed salmon, going against the ethnographic assumption that dogs in hunter-gatherer contexts throughout the world were kept to dispose human waste and garbage (Guiry 2012).

Hypothesis 1 argues that dogs were sustained at HP 54 for many generations because inhabitants wanted to reap benefits. The versatility of dogs allowed them to act as hunting aids, beasts of burden, and as a food resource. Canids would then have had a direct impact on household economy related to the acquisition of surrounding resources which predominately included ungulates and salmon. As successful hunters and haulers, the general test expectation assumes that pack sizes are generally larger during instances where bone element frequencies are high. On the flip side, Hypothesis 3 suggests that they were solely consumed during episodes of resource depletion; canid frequencies should be larger during instances where bone element frequencies are low. Hypothesis 2 explores whether raising and deploying hunting dogs was an efficient tactic in increasing resource utility within the Middle Fraser landscape and if so, was

this more prevalent in instances of resource scarcity. Based upon the HP 54 zooarchaeological record, dog frequencies fluctuated through time as do the bone element frequencies for various fauna. Via statistical analysis, this research examined whether or not dogs acted as a viable form of “currency” within a dynamic household economy: housepit inhabitants “investing” on dogs (i.e. time and energy to raise and cost of feed) to reap benefits. It was necessary to see if dogs had any association with the faunal remains and if these associations reflect logic behind the practice of canid ownership.

Principal components analysis (PCA) aims to consolidate complex datasets in the pursuit of identifying underlying patterns. If there were patterns and strong correlations present, then the assumption is that dogs contribute to household gain, thus supporting H1. Results suggest that dogs were particularly important economic assets during specific periods: IIb, IIc, and IIf. These floors represented fruitful conditions in HP 54 lifespan, notable for increases in the amounts of animal being hauled into the household. Dogs have a particularly strong presence in the IIb floor, a period where mammal bone frequencies increase alongside a nearly 400% expansion in fish remains IIc (Walsh 2015:163) (Table A.1). IIb has been interpreted as an episode of high population density (e.g. Reitz and Wing 2008:8). However, FCR and feature densities suggest that the IIa period housed the largest population (Prentiss personal communication 2016). FCR, along with lithic debitage, is also an indicator of occupation intensity as artifact frequencies should reflect number of person hours spent at a given location (Kuhn and Clark 2015:10).

The study’s results do not support H3 because canid frequencies were at their lowest in the earlier floors where ungulate and salmon NISP would occasionally dip. Thus, dogs would not live up to their potential for benefit gain during periods where either: 1) populations were low

enough that dog upkeep was unsuitable; 2) sample size bias prevented the research from uncovering more canid samples since there are data gaps in the earlier floors.

Although this study was able to find strong correlations between dogs and the faunal record, it is still archaeologically difficult to determine exactly how dogs made their economic impact. The strength of the PCA allows for determining whether certain variables have any significance within complex patterns; in this particular case, the study asks whether dogs contributed to HP 54 economy at all. The weakness of the PCA is that, even though it is possible to tease out patterns and correlations, it can be difficult to assess why these patterns and correlations exist without other sources of data. In order to combat this issue, relative abundance indices on mammalian axial and appendicular elements allow human behavioral ecologists to interpret underlying hunter-gatherer tactics; the assumption is that meatier appendicular elements were selectively carried back from farther distances whereas the less calorically rich axial counterpart was hauled from ideal proximate basecamp locations. Results were somewhat problematic since taphonomy and the high number of indeterminate mammals could have skewed certain floors. However, a strong appendicular signal is evident in the IIb floor, the same floor where dogs were relatively abundant. If dogs were at all deployed during hunts, it would have been most cost-effective during this time period.

H1 Observations

Results suggest that dogs act as fluid “foraging currencies,” having cost more in earlier periods compared to later strata such as IIb. “Foraging currency,” by definition, is anything that measures the efficiency (optimality) of a given practice in resource acquisition (Bettinger

1991:114). However, modeling optimality requires that each type of currency be linked with multiple constraints, thus inhibiting the researcher from evaluating foraging decisions on the basis of monetary contingencies. It is these constraints that raise the cost of a particular foraging currency. In the context of Bridge River, an obvious constraint that can raise the cost of optimal dog use is the lack of salmon. For example, Shimek's (2014) study on domestic dog use in ethnography found that there are significant statistical associations between the availability of dog food (when using a group's reliance on hunting as proxy) and a group's reliance on dogs as traction animals. Other costs to consider involve the interior space requirements for dog to roam and the time and energy investment needed to raise puppies into adulthood. Despite the variability of constraints, since dogs were most prominent in the IIb economy, dog upkeep was a practice that aimed to tactfully uphold long term investment, a choice that had not been as prevalent in other periods of HP 54 history; it seems as though the following conditions made dogs cheaper than it was in the past: high population density and consistent resource availability and attainment. Although the earlier IIh floor also retain high dog NISP (Table A.1), component scores are generally not as strong when compared to IIb-IIa perhaps due to lesser economic impact. IIc, on the other hand, exhibits high dog NISP while also retaining strong factor scores for terrestrial fauna, indicating one instance where dogs had some economic impact during an earlier stage in HP 54 occupancy.

Dogs' involvement in late-stage resource-based economy coincides with the precursor to village abandonment. IIb represents a boom in population density alongside IIg and IIe as reflected in proxies such as lithic debitage density measurements, FCR density, cache pit values, and the availability of hearth features that indicate increased cooking frequencies (Walsh 2015:177); this is an important observation since forager population growth can inhibit

population growth of fauna that is routinely incorporated in the same population's diet. Thus, ideal environmental conditions (one that would otherwise support an increase in prey carrying capacity) can potential slow down instances where high levels of foraging practices persist through time (Bettinger 1991:129). The roles of dogs could have been particularly fluid in this time period.

H2 Observations

Axial and appendicular element ratios in the IIB floor support the idea that, if dogs were used in hunts, they more likely would have done so in later stage Bridge River occupancy. Thus, dogs could have directly propagated adverse effects on prey population growth. Under the framework of the central place foraging model: dogs as hunting aids would have increased the efficiency of hunting such that desired ungulate utility is retained even when extending beyond maximum foraging distance. Hunting dogs would have then contributed to direct effects on prey availability since they would have consistently provided HP 54 with above average rates of resource acquisition. This benefit would allow for an already large household population to sustain themselves more fruitfully than in the past, even when earlier periods had smaller household densities.

Further Discussion on Costly Signaling

This study solidifies dogs' prominence during the period of heightened village-wide inequality. Combating fluctuating food supplies would have called for Bridge River households

to gain mutual assistance via egalitarian alliance formations (Hayden 2009; Wiessner 2002). Neighboring Housepit 24 utilized canids as feasting apparatuses, converting dogs into high value socioeconomic and political currencies by making them a food resource (Cail 2011). The same tactic could have been deployed at HP 54, albeit at smaller scales and most likely less frequency given the relatively low number of dogs in the archaeological record. If dogs were cooked in extravagant feasting events, they would have perpetuated the need to sustain and preserve household prestige in a village-wide arena. The increase of dogs would then have coincided with increase of fauna overall as well as the increase of outdoor cooking ovens (a sign of increased communal feasting) after the BR2-BR3 transition (Walsh 2015). Thus, the presence of dogs in archaeological record of Bridge River households should correlate with periods in which resource acquisition intensified in order to meet the needs of displaying prestige to attain alliance-based benefits.

Following Veblen's (1899) logic, dog's "conspicuous consumption" of high value sockeye salmon, upkeep energy, and upkeep time is an instance where "conspicuous expenditure" results in indirect economic advantage. If this is the case, it seems as though costly signaling was only beneficial during periods where household population densities were higher; these periods also coincided with village-wide material wealth based status inequality. Dogs would then act as "fluid socioeconomic currencies." "Fluid" would define to how their roles would shift frequently, accommodating HP 54's need to sustain stature resulting in benefits (i.e. alliances). Beyond feasts as mentioned previously, there are other instances where dog upkeep can build and maintain social and political relationships; it is difficult to assess archaeologically because there is no direct tangible evidence. For example, their role as guard dogs and the implications on how this signal plays out in an intricate village dynamic. In another instance,

Coastal Salish women are known to have kept their own breed of dog in which their hair would be woven into blankets. The number of dogs a woman owned would be diagnostic of her health (Schwartz 1997:56).

Spending time and energy in dog upkeep was worthwhile in instances where dogs were highest in value. Dogs become more prominent after the BR2 to BR3 transition; this is important to note because: 1) BR3 initiated with low salmon frequencies which later spiked from IIc onwards until IIa; 2) there is evidence village-wide evidence of wealth-based inequality. Hewes (1973:140) estimates that a single dog would require one kilogram of salmon per day on average. Given that fact, if dog ownership were to be practiced in Bridge River at any capacity, it would hypothetically be most prominent the later occupation floors; this, of course, was the case. Prestige objects (e.g. pendants, jade artifacts, beads) and prestige raw materials (e.g. obsidian, steatite, nephrite jade) were prominently found only in select BR3 homes (Prentiss et al. 2012).

Conclusion

Dogs appear in the Bridge River archaeological record throughout the highs and lows. From small to large population densities, shifting faunal frequencies, and the emergence of inequality, dogs thrived within these dynamic changes up until village abandonment. This study attempts to assess the worth of dogs within a cost-benefit context because the practice dog upkeep should hypothetically yield some form of benefit. The project assumes that their provisioning of benefits translates to tangible remains that can be read via the archaeological record, specifically dog's contribution to the acquisition of both aquatic and terrestrial fauna for household use. Whether dogs were heavily utilized or highly sufficient during hunts, hauled

loads of fish from the river, or were consumed in moderation or in special occasions or rituals (see Cail 2011 and Teit 1900), the study suggests that dogs worth within household economies fluctuated alongside both population dynamics and the availability of resources. Certain conditions that favored dog upkeep (i.e. abundance of fish for feed) could open up the opportunity for further exploitation to enhance household gain. Dogs are expensive to maintain, but when invested at the “right moment,” HP 54 inhabitants seemed to have welcomed canine compatriots with open arms.

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Appendix. Table A.1

Taxon	Ila	Ilb	Ilc	Ild	Ile	If	Ilg	Iih	Iii	Iij	Total Assemblage*
Osteichthyes	1055	1880	478	235	272	488	149	134	114	71	4876
<i>Salmonidae</i>	210	673	16	13	0	0	0	0	0	0	912
cf. <i>Oncorhynchus nerka</i>	742	1035	380	181	248	387	138	131	110	63	3415
cf. <i>Oncorhynchus tshawytscha</i>	49	4	0	1	0	6	1	1	0	0	62
cf. <i>Salmonid</i> (trout-sized)	27	41	6	4	3	19	0	3	0	7	110
Indeterminate	27	127	76	36	21	75	10	0	4	1	377
cf. Gadidae	0	0	0	0	0	1	0	0	0	0	1
Mammalia	1260	721	604	278	312	542	375	120	75	84	4371
Small	13	13	1	12	15	1	0	0	4	1	60
Medium	32	77	78	104	40	59	6	14	5	8	423
Small-Medium	12	15	8	4	4	0	27	1	25	0	96
Large	187	219	350	71	76	179	96	25	17	14	1234
Medium-Large	723	329	133	47	171	294	130	33	12	56	1928
Indeterminate	290	53	34	10	7	11	114	48	12	5	584
Artiodactyla	108	89	46	15	41	64	38	21	16	11	449
Indeterminate Cervidae/Artiodoc	12	17	2	4	13	26	2	1	1	0	78
<i>Odocoileus hemionus</i>	21	92	40	11	26	38	34	18	14	10	304
<i>Ovis canadensis</i>	15	0	4	0	2	0	1	2	1	1	26
<i>Oreamnos americana</i>	0	0	0	0	0	0	1	0	0	0	1
Carnivora	6	8	6	5	1	7	1	7	0	2	43
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	0	1	0	0	0	0	0	0	1
Canis sp.	6	8	6	4	1	7	1	7	0	2	42
<i>Martes sp.</i>	0	0	0	0	0	0	0	0	0	0	0